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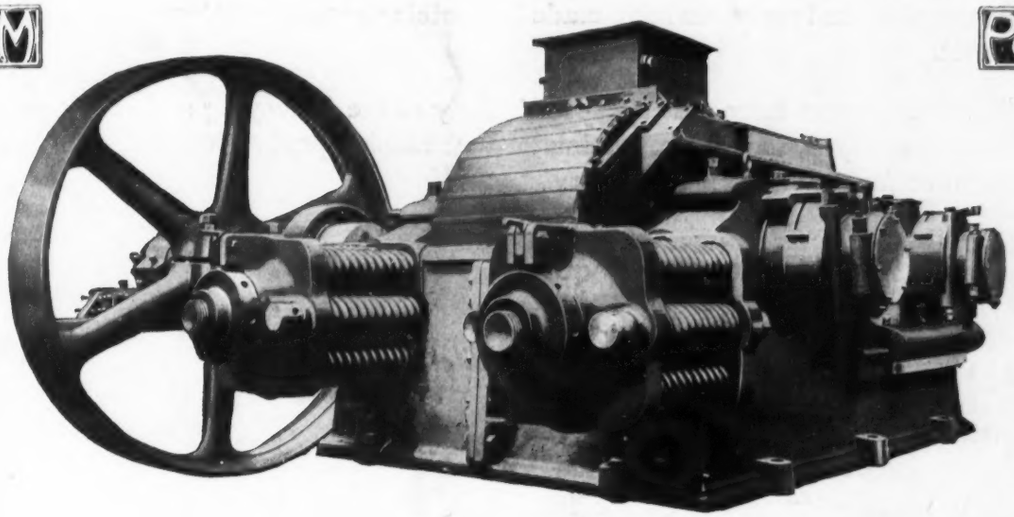

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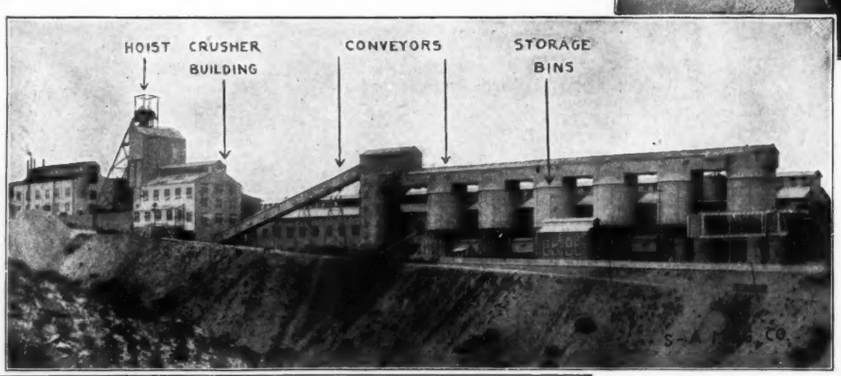
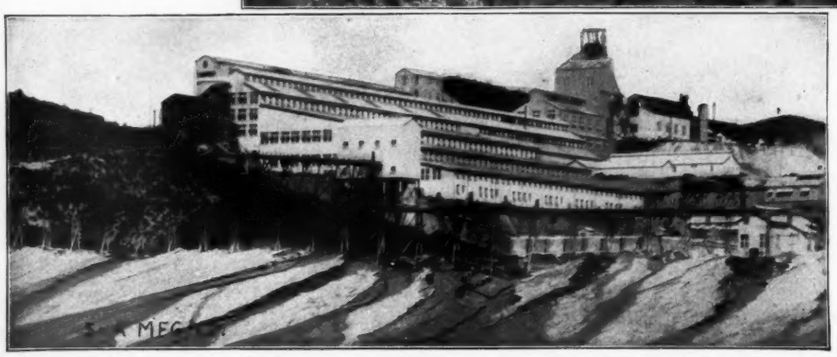


The middle illustration shows the main features in the conveying systems of this enormous plant.



The upper cut shows one of the many gallery conveyors handling the ore in the immense concentrator pictured in lower cut.

Mining Journal

VOLUME 101 MARCH 18, 1916 NUMBER 12

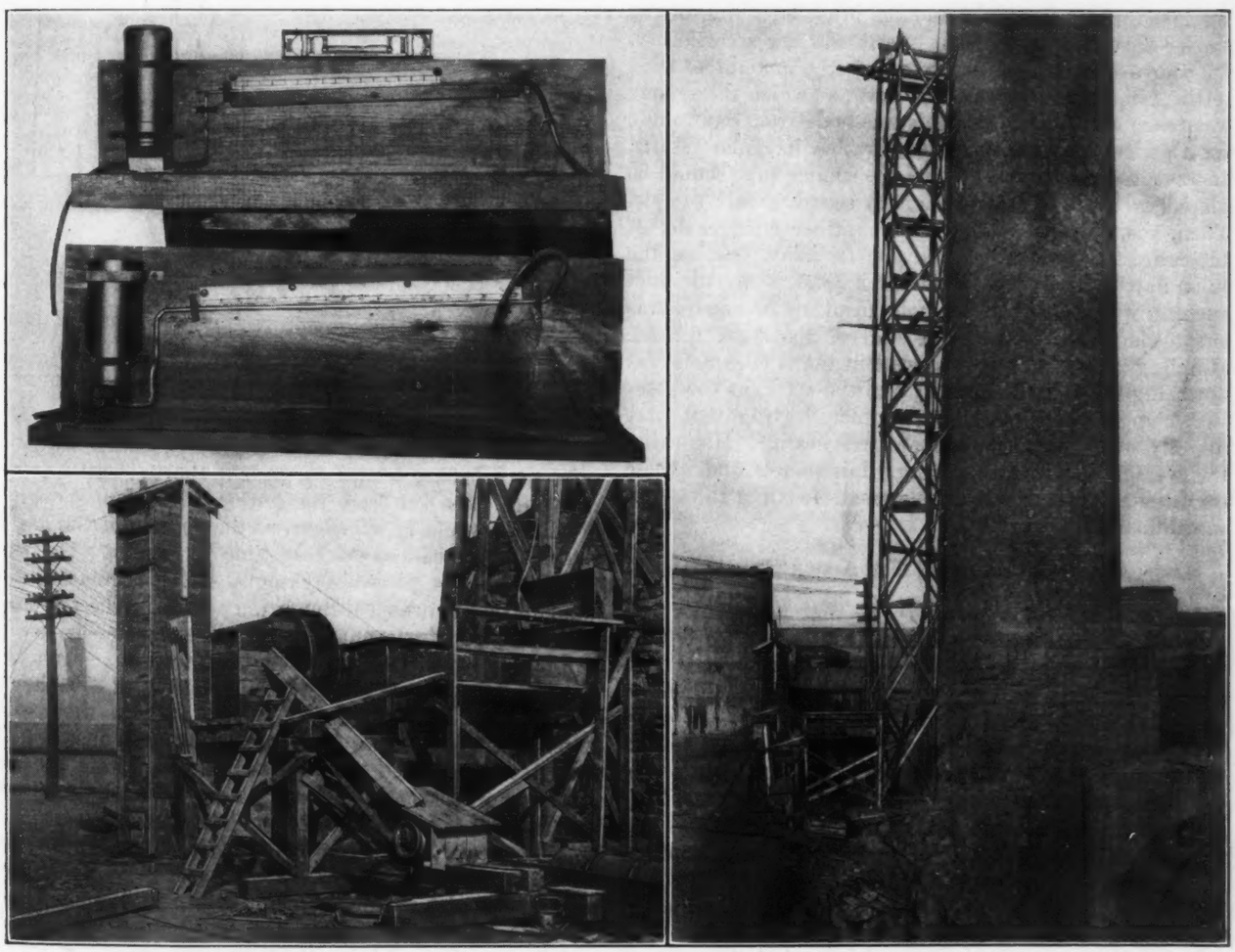
Method of Determining Dust Loss at Copper Cliff, Ont.

By Edward H. Robie*

SYNOPSIS—Gas velocity measured with Pitot tubes, dust precipitated in collecting chamber and fume caught in baghouse. No fabric found to withstand corrosion of gases; in later tests, amount of fume was arbitrarily estimated.

In the smelting of copper ores there is considerable dust blown out of the furnaces, not all of which is collected in the dust chambers commonly employed. Just what the loss out of the stack amounts to was the object of several tests at the plant of the Canadian Copper Co., Copper Cliff, Ont., and the method of carrying out the most recent determination of losses from the blast-furnace stack and the manner of recording the more important data will be here described. The same method is applicable to the determination of losses from roasting- and reverberatory-furnace stacks and in any case where the valuable constituents of the gas may be recovered by properly reducing the gas velocity, affording sufficient precipitating surface, and cooling to normal temperatures.

*Canadian Copper Co., Copper Cliff, Ont., Can.



APPARATUS FOR DETERMINING DUST LOSSES AT CANADIAN COPPER CO.'S WORKS

View on the right shows completely assembled apparatus for taking samples of dust-laden stack gases, about 70 ft. above stack base, and for precipitating the dust. In the lower left-hand corner is a closer view of the precipitating apparatus, and above are some home-made manometers used in the tests

Briefly, a small portion of the gas is drawn from the stack, the dust recovered, and the dust escaping from the stack calculated by multiplying the weight of that recovered by the ratio of the volume of the gas sample taken to the volume passing up the stack. This method therefore involves a determination of gas velocities and volumes, which in turn necessitates a determination of the gaseous composition of the stack gases, so that at the end considerably more information is available than merely the dust loss.

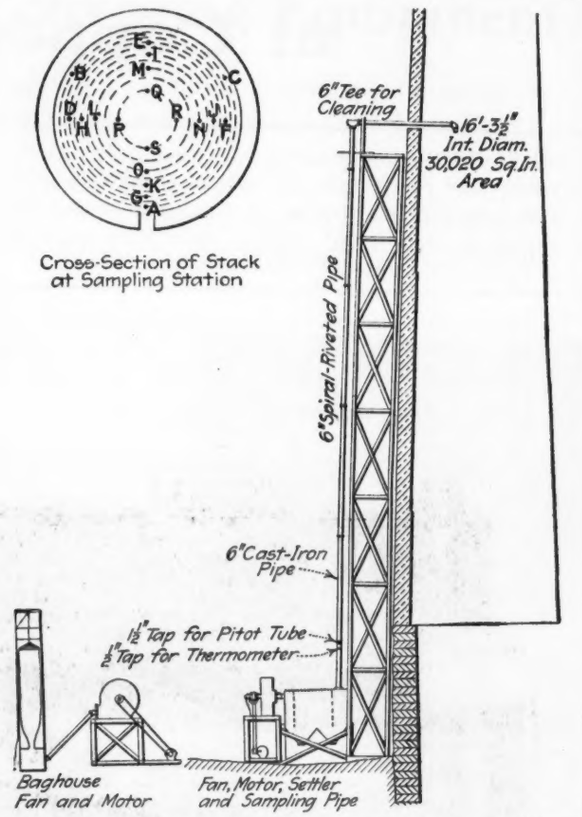
The method used at Copper Cliff will be described in sufficient detail so that it is hoped it can be adapted to local conditions at other smelting works. The Sudbury sulphides comprise a mixture of chalcopyrite, pyrrhotite and pentlandite. The blast-furnace equipment of the Canadian Copper Co. consists of five 17-ft. furnaces, one 21¼-ft. furnace and one 25½-ft. furnace, all discharging into a balloon flue 20 ft. in diameter and 475 ft. long. The balloon flue, together with a boiler flue from the steam-power plant, 8 ft. in diameter, used only occasionally, discharges into a brick stack 210 ft. high, internal diameter at the bottom 15 ft. 7½ in., and at the top 15 ft.

The first thing to be decided in such tests is where is the best place to take the sample and obtain velocity readings? Three sets of experiments have been run on the blast-furnace gases at Copper Cliff. In the first the sample was taken from the balloon flue midway between the last furnace downtake and the brick breeching of the stack—a station whose only merit was its accessibility. Of course it was necessary to weigh the amount of dust settling in the flue between the point at which the sample was taken and the stack. This was done from day to day for a period of several weeks with rather irregular results. It was also doubtful just where the sample pipe should be placed in the flue cross-section to secure a fair sample. Then, too, the gas currents were rather changeable, as the nearest downtake was only 90 ft. away. So, on the second attempt, a point in the stack 28 ft. above the inlet opening was selected and a hole about 18 in. square was cut through the 26-in. brick wall of the stack for the sampling pipes. It was soon evident that the sample was not being taken high enough up in the stack, as the gases swept up the side opposite the inlet, leaving that part directly over the inlet comparatively calm. Measuring the average velocity and getting a fair sample under these conditions with a comparatively small hole in a thick wall was difficult.

Gases Sampled About 76 Ft. Above Stack Base

In the last test a point 76 ft. above the inlet was selected. It was possible to erect a staging up to this point, which was not too difficult to climb up and down and at the same time seemed to be a sufficient distance above the inlet so that the velocity was nearly the same over the entire cross-section. Should the stack not be over 150 ft. high, it might be advisable to run the sample pipe up over the top and down a short distance inside. This obviates cutting a large hole through the stack and was the method adopted in determining the dust loss from the Wedge furnace stack at this works.

Having cut the hole in the stack wall, a 6-in. sampling pipe was introduced, fitted with an elbow and a short nipple facing the gas flow. A 6-in. spiral-riveted pipe carried the gas down to the settler, which was merely a sheet-steel box 5 ft. wide by 5 ft. deep by 8 ft. long, with two hoppers in the bottom and a removable top. Across the inside, about two feet from each end, was stretched ordinary wire cloth to provide additional precipitating surface for the dust. The sheet-steel cover was bolted on, and rubber gaskets and white lead were used to make a tight joint. The settler was of sufficient size so that the average velocity of the gas drawn through it would be 3 in. per sec., or 15 ft. per min., thus taking 30 sec. to traverse the length of the box. However, the gas would not spread itself out over the whole box, so that the maximum velocity was greater than this. The gas entering



APPARATUS FOR DETERMINING DUST LOSS AT COPPER CLIFF, ONT.

from above and discharging at the side, together with the wire-cloth baffles, tended to prevent short-circuiting.

A 6-in. pipe led from the settler to the fan, though a 5-in. pipe would be sufficient, as the volume of the gas is considerably reduced by this time by cooling. In this short pipe was placed a gate valve for regulating the amount of gas drawn through the system. The fan used was a No. 55 Sturtevant planing-mill exhauster driven by a 5-hp. motor at a speed of about 1,100 r.p.m. From the fan the gases passed down into the bottom of a baghouse about 3 ft. square by 18 ft. high, where they were filtered through a bag to recover the finest dust, which had not settled, and then allowed to escape into the air. The bag was suspended from a hoop fastened to a wire rope so that it could be shaken and raised and lowered.

No material for the bag was found that would resist the corrosive action of the gas. As an experiment we secured several samples of all-wool and cotton and wool mixed flannels and blanket cloths, moistened them with dilute sulphuric acid and hung them up. In one to two days every sample had been greatly weakened. The most resistant sample was selected and the bag made of this

cloth. It was then thoroughly impregnated with lanolin, or wool fat, as it has been stated that natural wool resists corrosion from acid much better than greaseless manufactured wool. We also tried to pick out dry weather for our tests, but were uniformly unsuccessful. At the end of 2½ days of continuous running, the bag began to fall apart and was useless for further work. Only a small amount of dust was caught by the bag while in commission—about 2% of the amount collected in the settler—so thereafter the gas was passed through a bagless baghouse; what little dust collected on the floor was scraped up and weighed and 2% empirically added to the dust caught in the settler to make up for the lack of any filtering medium. In other tests cleaning the gas by passing it through a water spray was tried, but this requires weights, analyses of the sludge made and of all the water used, which are difficult to get accurately. Various methods for filtration of fume are described in H. O. Hofman's "General Metallurgy," p. 848 *et seq.*

Gas Velocity Measured by Pitot Tubes

The measurement of the gas velocity in the stack and in the sample pipe was done by means of pitot tubes. This method has been thoroughly described by Prof. C. E. McQuigg in *Engineering and Mining Journal* for Mar. 29, 1913, and by W. C. Rowse in the "Journal of the A. S. M. E." for September, 1913. Both of these articles should be read and thoroughly understood before attempting work with the pitot tube.

In order to get the average velocity in the stack, the cross-section was divided into five zones of equal area, as shown by the heavy dotted lines in an accompanying illustration. Each zone was then divided into two portions of equal area, as shown by the light dotted lines, and at various points on these lines (*A, B, C, D,* etc.) pitot-tube readings were made. An average of the velocities found at *A, B* and *C* will give approximately the average velocity in the outer zone; at *D, E, F* and *G,* the average velocity in the second zone, etc. The average velocity in the whole cross-section is then the average of the velocity in each zone, since they are equivalent. The more zones into which the stack is divided the more accurate the results, the more time required to get a set of readings and the less work that will be accomplished in a given time.

It is not necessary to calculate the velocity at each point, but only to average the square roots of the velocity heads for each zone as read on the manometer gage. The velocity heads themselves must not be averaged, for what we want to substitute in the equation for the pitot tube is the mean square root of the velocity head, which may be quite another thing from the square root of the mean, particularly if the readings vary much. In making readings over a vertical cross-section, the static tube must be kept near the impact tube for every reading, for if one tube is near the top of the flue and the other near the bottom, erroneous readings will be obtained.

After running several pitot-tube surveys of the stack, we were able to determine the relation between the average velocity at any point and the average for the stack. The average velocity at point *O* was found to be 41.5 ft. per sec., while the average for the stack was 42.8. The sample was taken from point *O,* and velocity and static head, temperature and barometer readings were taken every half-hour during the test. Once each day pitot-tube readings were made on the entire cross-section in order to make sure that conditions had not changed the ratio of the velocity near the sample-pipe inlet to that of the entire cross-section.

It is important to secure accurate temperatures of the gas, and thermometers were found more accurate than the pyrometers used in some of the earlier tests. They should be nitrogen-filled, as the mercury in ordinary thermometers separates at the temperatures prevailing in the ordinary flue. A case to hold the thermometer was made out of a piece of 1-in. pipe 6 ft. long. At one end a slot was cut, through which the scale could be read, and the instrument was then packed in with asbestos and a cap put on each end of the pipe. A 16-in. armored thermometer graduated to 1,000° F. for total immersion was used, obtained from the Taylor Instrument Co. for $12.50. The whole was kept hanging in the stack and withdrawn every half-hour for readings.

The velocity in the 6-in. sample pipe was obtained by means of a pitot tube inserted about 10 ft. from the bottom, readings being made every half-hour. The impact tube was kept at the center of the pipe and the velocity obtained multiplied by 0.87 to correct for the diminished velocity along the walls. This factor depends on the size of the pipe and local conditions and must be determined by making a survey of the pipe cross-section in the same manner as already described for the stack. In this survey, for the static head a small tube flush with the wall of the pipe was used and for the impact head, a small piece of glass tubing bent at right angles to face the gas flow. In all this work great care must be used to keep the instruments free of flue-dust obstructions, and to this end it is very handy to have a compressed-air line handy for blowing out the tubes. Also all joints must be absolutely gas-tight—wired and shellacked. Glass tubing should be used as much as possible and connected up with heavy rubber tubing. A manometer gage may be purchased, but the home-made affairs shown in an accompanying illustration are not difficult to make of any desired degree of sensitiveness, and if carefully calibrated, serve every purpose.

A reliable barometer is a necessity for accurate work. An aneroid barometer is preferable to the mercury type, which is subject to numerous corrections. It must be occasionally checked up with a mercury barometer, however, by someone that understands how to read it. The barometer may be kept on the ground for stations up in the air and a deduction of 0.01 in. of mercury made for every 9 ft. difference in height.

Formula for Calculating Velocity

Knowing the velocity in the bottom of the sample pipe, the velocity at the inlet may be calculated as follows:

$$V_1 = V_2 \times \frac{T_1}{T_2} \times \frac{B_2}{B_1}$$

where

V_1 = Velocity at inlet;
V_2 = Velocity at bottom;
T_1 = Absolute temperature at the inlet;
T_2 = Absolute temperature at the bottom;
B_1 = Absolute pressure at the inlet;
B_2 = Absolute pressure at the bottom.

The valve near the fan should be so regulated that the velocity in the inlet is approximately the same as in the stack near the inlet.

After starting the fan, it was kept running continuously for about 2½ days and then the collected dust

removed from the pipes, settler and baghouse, and screened and assayed. The vertical pipe leading to the settler was first well hammered to remove the dust clinging to the walls. It was found that the dust caught in the settler was of lower metallic content than the dust recovered from the balloon flue and that the dust caught in the baghouse was of still less value. This is probably due to the fact that the lighter portions of the dust blown from the furnaces, the coke, coke ash and rocky parts of the ore contain less metallics than the heavier portion and are settled with greater difficulty. The dust that escaped from the stack therefore cannot be assumed to be as valuable as the dust recovered.

Two tests were run—the first lasting 62 hr. and the second, 80 hr. At the end of the second test the inaccessible parts of the system, which could not be cleaned at the end of the first run, were thoroughly cleaned and the dust thus obtained distributed pro rata over the two runs.

The summary of a test of this kind should contain all the information possible regarding conditions affecting the results obtained. The test described was summarized in the following form:

SUMMARY OF TEST TO DETERMINE STACK LOSSES

Date: ....
Total time of run: .... hr. .... min.
Average velocity in stack at point 84 ft. from ground and 67 ft. above top of masonry: .... ft. per sec.
Average velocity in stack near sample-pipe inlet: .... ft. per sec.
Average velocity of gas in sample-pipe inlet: .... ft. per sec.
Temperature of stack gas at sampling point: ..... Minimum during test was .... and maximum, ...
Draft in stack at sampling point: .... in. of water.
Number of furnaces running during test: .....
Average pressure at furnace bustle pipes: .... oz.
Average percentage of fines on charge: .....
Volume of gas going up stack in cu.ft. per hr.....
Volume of gas going up stack in standard cu.ft. per hr. (32° F. and 29.92 in. Hg.): .....
Volume of gas drawn into settler in standard cu.ft. per hr.: .....
Total dust caught during test: .... lb. containing ....% CuNi.
Average pounds dust lost up stack per 24 hr.: .... @ ....% CuNi or .... lb. CuNi.
Average pounds dust lost up stack per ton ore charged: ..... Per ton total charge .....
Pounds CuNi lost from stack per 1,000 lb. CuNi charged: .....
Percentage of ore charge going up stack: .....; percentage of total charge: ....; percentage of CuNi charge going up stack: .....
Pounds dust loss per 1,000,000 standard cu.ft. of stack gases: .....
Estimated velocity at top of stack in ft. per sec.: .....
Estimated volume at top of stack in cu.ft. per hr.: .....
Estimated velocity at base of stack in ft. per sec.: .....
Estimated volume at base of stack in cu.ft. per hr.: .....
Screen test of dust recovered from balloon flue during test: .....
Screen test of dust caught in experimental settler: .....
CuNi assay of dust recovered from balloon flue: .....
Composition of stack gas: ....%; ....H_2O; ....SO_2; .... SO_3; .....CO_2; .....N_2.

In some earlier tests made at this works, these data were not conveniently recorded and it was difficult to dig up old records to find the reasons why one set of results varied from another.

Production of Quicksilver in California in 1915

According to the returns for 1915 now coming to Fletcher Hamilton, state mineralogist, data have been received from a sufficient number of the quicksilver mines of the state so that a fairly close estimate of the output can be made. This is placed at 12,450 flasks of 75 lb. each. The year's output was valued at $1,068,210, or nearly double that of 1914, which was $557,846 for 11,373 flasks.

Some very interesting developments are taking place at the present time along the line of concentration of quicksilver ores, particularly at the Oat Hill and Aetna mines in Napa County, at the New Idria mine in San Benito County, the Kings in King County, and at the Oceanic in San Luis Obispo County.

Flotation Oils at Anaconda

During the experimental work on flotation at the Anaconda concentrator, described by Laist and Wiggin in a paper to be read at the Arizona meeting of the American Institute of Mining Engineers, September, 1916, a description of the results obtained by some special oils was given. From the Union Oil Co. of San Francisco, there was received a sludge-acid kerosene known as M. S. 37. It was used practically all through the experimental work. It gives highly satisfactory results. Although exposed to the weather in iron drums during the winter months, it gave no trouble by becoming too viscous. From the Standard Oil Co. of San Francisco came a sludge acid that gave just as good results in the flotation work as that from the Union Oil Co. This oil did not become viscous when exposed to freezing temperatures.

One barrel of oil from the Western Oil Co. was tested during February in the M. S. No. 1 machine when treating round-table feed. This oil did not give as satisfactory results as the two preceding. About one-third of it was left in the barrel as a solid residue. One barrel of oil from the Midwest Refining Co. was tested during February in the M. S. No. 1 machine when treating round-table feed. The results obtained were not as good as those obtained when using the first two oils. At least one-half of this oil remained in the barrel as a solid residue which could not be liquefied even by using the steam coils. From the Producers Refining Co. came an oil that could not be tested, as it was solidified in the barrels and did not become liquid after standing for days at a temperature of 60° F. or better.

During the experimental flotation work creosote oils were tested with the following results: The creosote from Cleveland-Cliffs Iron Co., of Marquette, Mich., is obtained as a byproduct in the manufacture of charcoal from hard pine. This is known as M. S. No. 33, the number given to it by the Minerals Separation Co. It was used practically throughout the entire work with highly satisfactory results. Creosote from Pensacola Tar and Turpentine Co., of Gull Point, Fla., was used in considerable quantity in experimental work. It gives fully as good results as the Cleveland-Cliffs creosote. It is made from Georgia pine wood. This oil is known as No. 400 by the Pensacola company.

A barrel of creosote from Crichton Pine Products Co., of Alabama, was tested and gave good results. A test was made using a barrel of tar creosote from the Butte Gas Works, which gave fairly good results. The test was too short to be conclusive, but it is thought that the tar creosote would give satisfactory results.

In testing the Callow machines, a mixture of oil containing tar creosote from the Barrett Manufacturing Co. was used with good results. In the laboratory tests it was found that the tar creosotes give good results. Creosote from the timber-treating plant at Rocker comes from the J. F. Lewis Co., of Moline, Ill. It did not give good results, although the test was too short to be absolutely conclusive. The oil contained a good deal of dirt and sediment.

Sedimentation and Flocculation*

By E. E. Free†

SYNOPSIS—The causes of flocculation are here discussed. Much of the anomalous behavior of colloidal slimes is due to differences in flocculation. Its degree may be increased or decreased by various procedures, some of which are outlined. Discussion of the possibilities of selective flocculation.

Before proceeding to the organic deflocculators, it may be well to say a word as to possible causes of the flocculating action of salts and alkalies. No complete theory has been formulated, and none seems possible at present. There are, however, three ways in which dissolved substances might be expected to affect the degree of flocculation: (1) By changes of surface tension and other surface forces, (2) by changes of electrical charge and (3) by changes of mutual solubility of particle and medium. The importance of the surface forces between particle and medium was pointed out in the preceding article of this series, and the presence of small amounts of dissolved substances is known to affect these forces very largely. The efficacy and mechanism of changes in the electric charge resident on the particles are obvious. The matter of mutual solubility is equally manifest when it is considered that the surface of demarcation between particle and medium is never absolutely sharp, but that the particle always dissolves, slightly at least, and the medium always penetrates to some small extent into the surface layer of the particle. It is easy to imagine that other substances dissolved in the medium may alter these relations, with resulting secondary effects on surface forces and the degree of flocculation. Phenomena of this kind are known to control a kind of flocculation, commonly called gelatinization, which occurs in liquid-particle colloids. How important they are in solid-particle suspensions is not known. Indeed the whole matter of the cause of flocculation and deflocculation by acids, salts and alkalies is entirely speculative and need not detain us.

So-Called Protective Colloids

Concerning the effect of the remaining class of deflocculators, the organic colloids, there is, paradoxically, rather less of precise experimentation but more of theoretical understanding. Substances of this class tend to prevent the flocculation normally existing or which would otherwise occur on the addition of flocculating agents. It is a matter of common knowledge that glue, gelatin and the like will prevent the subsidence of suspensions, and the similar effects on plastic clays have long found commercial employment. E. F. Acheson's "deflocculated graphite," now coming into prominence as a lubricant, owes its permanence of suspension to the presence of materials of this sort.[10] It is significant that these deflocculating effects are exhibited only by emulsoids—that is, by colloids composed of liquid particles. It has been suggested that the protective action is due to the coalescence of the liquid droplets of the colloid with the particles of the suspension that it is stabilizing. In this manner liquid surface films of the protective colloid are formed about the particles of the suspension, and the resultant change in surface properties is supposed to be responsible for the failure of these particles to flocculate and subside. There is much evidence favorable to this conception of the action of protective colloids, and knowledge of this behavior has probably contributed to the origin of the current misconception of specific colloidal substances in ores, as discussed in the preceding article. If substances of the protective colloid class were actually present in ores, they would behave in this manner, but their presence has not been demonstrated and seems very improbable. The matter will be discussed in detail in a later article.

The protective, deflocculating action of organic colloids seems to be the effect characteristic of these bodies as a class, but it is not always exhibited. A few such substances have no apparent action on mineral suspensions, and cases are recorded in which glue, gelatin, soap and the like appear to promote flocculation rather than the reverse. A number of cases and some interesting experiments will be reported by O. C. Ralston in a forthcoming paper to which I shall refer more specifically in a moment. Little is known as to the mechanism of these anomalous effects. Purely as personal opinion, I imagine that there occur chemical reactions between the organic colloid and some constituent of the solution. This probably explains, for instance, the clarifying action of a mixture of gelatin and salts of iron. The questions suggested must remain open, as also the matter of the effects that may be produced on suspension by the inorganic emulsoid (liquid-particle) colloids such as ferric hydroxide or colloidal silica in the form of silicic acid. In this last case Caldecott[11] has found the rate of slime settling decreased by added colloidal silica, but one case is scarcely sufficient to establish a general principal.

It is interesting that the deflocculating power of organic colloids and their parallel power of inhibiting crystallization have recently been put to commercial use in the prevention of the formation of hard scale in steam boilers.[12] A small amount of colloid added to the boiler water appears to be remarkably efficacious.

Excessive Colloidality Due to Deflocculation

In summary of the matter of flocculation, it appears that in the kind of systems with which we are concerned here and which are typified by colloidal slimes, the normal condition is not a complete deflocculation, each particle for itself, but is a certain medium degree of flocculation the actual amount of which depends upon the specific materials and circumstances concerned. This degree of flocculation can be increased by salts and acids and decreased by alkalies in certain concentrations. Flocculation can be prevented by organic emulsoid colloids. There is no evidence that these bodies are active deflocculators,

*This is the third of a series of articles on Colloids in Ore Dressing. Previous articles appeared in the "Journal" of Feb. 5 and Mar. 4, 1916. The fourth of the series will treat of Rate of Slime Settling and will appear in an early issue.

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[10]Acheson, "Eng. News," Vol. LIII, pp. 127-8 (1907).

[11]"Journ. Chem. Met. Soc. S. A.," Vol. VII, p. 217 (1907).

[12]Wherry and Chiles, "Eng. Mag.," Vol. XLV, pp. 518-23 (1913).

but there is no practical difference, since the mixing necessary to add the colloid is usually sufficient to break up the floccules which, in the presence of the colloid, are not re-formed. Floccules, however formed, behave in sedimentation like particles of larger diameter. Flocculation is therefore a most efficient and serviceable aid to increased rapidity of settling. Let us examine the practical bearing of these phenomena.

As was outlined in the first article of this series, the excessive colloidality of slimes from certain ores is not entirely a matter of fine grinding or unusual disintegration. Many noncolloidal slimes are composed of ultimate particles finer than those of the slimes that cause trouble. The difference is usually one of flocculation. An excessively colloidal slime must not only consist of very fine particles, but must be deflocculated. The satisfactory slimes are flocculated; the colloidal ones are not. In a given case this difference may be due to any one or more of many influences, most of which will be suggested by the preceding paragraphs. Not infrequently it appears to be due to the presence of small amounts of caustic alkali, especially with highly oxidized ores containing feldspar or other minerals capable of giving alkali by hydrolysis. It must not be imagined, however, that the addition of acid will be a general panacea. In the present state of knowledge it is impossible to formulate general principles. Each case of excessively colloidal slime must be regarded as distinct and specific, requiring individual study and an individual treatment. The cause of the excessive deflocculation must be sought for specifically and removed.

Aside from the matter of the discovery and removal of the cause of excessive colloidality, there are at least two procedures that may be employed to hasten the settling of slimes in general. First is the increase of the degree of flocculation by the addition of flocculating salts or acids, as suggested especially by Ashley.[13] From the curve of Fig. 2 it is apparent that the minimum active concentration (the threshold concentration) of sodium chloride is not high, and this is true of most of the flocculating salts. There is nothing inherently impossible in the practical use of such flocculating agents in ore dressing, and this is already done in several industries and is a common procedure in slime testing and in the analytical laboratory generally. An extensive and important series of experiments on the action of flocculating agents on slimes has been carried out by O. C. Ralston, of the United States Bureau of Mines, and is reported in a forthcoming paper by him. [Mr. Ralston's paper will appear in an early issue of the *Journal*.—Editor.] I am indebted to Mr. Ralston for the privilege of examining his valuable paper in advance of publication and shall have occasion to refer in this and following articles to many of his results.

Other experiments (with common salt and with ferrous sulphate) have been reported by Laist and Wiggins,[14] and Caldecott[15] has observed in practice the reverse, or deflocculating, effect of caustic soda. In this connection it should be noted that the acid or other solutions used in the several leaching processes, and probably also the usual cyanide solutions, have a certain flocculating action which is not without its importance, although the employment of these solutions is for other ends.

A word must be devoted to the use of lime as a flocculating agent, this material having been useful practically in the hands of a number of engineers.[16]

At first sight it would appear improbable that lime could have a purely physical flocculating action, lime being an alkali and the characteristic effect of small concentrations of alkali appearing (as cited) to be a deflocculation rather than the reverse. There is nevertheless a certain flocculating action exhibited by lime, even under laboratory conditions, and it appears that the hydroxides of calcium, and probably of magnesium, do not parallel the behavior of potassium and sodium hydroxides. It appears probable, also, that certain purely chemical factors enter as well and that the efficacy of lime as a clarifier is due in part to chemical reactions of the same sort as those which control, for instance, the action of aluminum salts in clarifying water.[17] These clarifying actions apparently depend upon the formation by chemical reaction of some flocculant precipitate that entangles and sweeps down the suspended particles. Probably the occasional cases of clarification by organic colloids, as already noted, belong to the same class.

Temperature and Slime Settling

The second procedure for hastening settling is already in use and consists in increase of temperature.[18] It will be remembered that the Stokes formula contains a term for the viscosity of the medium and that the rate of settling varies inversely with this viscosity. Rise of temperature decreases the viscosity of water, and a quicker settling of slimes is the result. There are also some effects of temperature upon the degree of flocculation,[19] but they are smaller and less important. Essentially the matter is one of viscosity only.[20]. The progressive de-

VISCOSITY OF WATER

Temperature °C.	Temperature °F.	Viscosity C.G.S. Units	Percentage Decrease of Viscosity per 10° C.
0	32	0.01793	....
10	50	0.01311	26.88
20	68	0.01006	23.26
30	86	0.00800	20.48
40	104	0.00657	17.87
50	122	0.00550	16.29
60	140	0.00469	14.73
70	158	0.00406	13.43
80	176	0.00356	12.31
90	194	0.00316	11.24
100	212	0.00284	10.13

[13]"Trans. A. I. M. E." Vol. XLI, pp. 380-95 (1910).

[14]"Bull. A. I. M. E.," No. 92, pp. 2201-16 (1914).

[15]"Proc. Chem. Met. Soc. S. A.," Vol. II, pp. 318-20 (1898).

[16]See, for instance, Richards, "Ore Dressing," Vol II, p. 1149, and Vol. III, pp. 1416-17 (1903 and 1909), also the following: Butters, "Proc. Chem. Met. Soc. S. A.," Vol. II, pp. 238-52 (1898); Caldecott, ib., pp. 318-20, 797 (1898); Ehrmann, ib., pp. 697-705 (1898); Carrick, ib., pp. 797-8 (1898); Tays and Schiertz, "Trans. A. I. M. E.," Vol. XXXII, pp. 179-215 (1901); Bishop, "Electrochem. and Met. Eng.," Vol. VII, pp. 72-4 (1909); Megraw, "Eng. and Min. Journ.," Vol. XCIV, p. 985 (1912), Vol. XCV, p. 986 (1913), Vol. XCVII, pp. 267-8 (1914); Spicer, "Met. and Chem. Eng.," Vol. XI, p. 408 (1913); Fleissner, "Oest. Zeits. Berg- und Hüttenw.," Vol. LXI, pp. 531-4, 550-1 (1913).

[17]As suggested by Prister, "Proc. Chem. Met. Soc. S. A.," Vol. II, pp. 255-6, 796, 803-5 (1898).

[18]Salkinson, "Journ. Chem. Met. Min. Soc. S. A.," Vol. VII, pp. 403-6 (1907); Vol. VIII, pp. 81-4, 142-4; Vol. IX, pp. 308-9 (1909); Bishop, "Electrochem. Met. Ind.," Vol. VII, pp. 72-4 (1909); Comstock, ib., p. 74 (1909); Ashley, "Min. and Sci. press," Vol. XCVIII, pp. 831-2 (1909), "Trans. A. I. M. E.," Vol. XLI, p. 387 (1910); O'Hara, "Journ. Chem. Met. Min. Soc. S. A.," Vol. X, p. 344 (1910); Caetani, "Min. and Sci. Press," Vol. CVI, pp. 439, 442 (1913).

[19]For instance, Hilgard found the degree flocculation less at boiling than at lower temperatures. "Amer. Journ. Sci.," Vol. XVII, p. 206 (1879). On the other hand Fleissner reports flocculation increased by cooling. "Oest. Zeits. Berg- und Hüttenw.," Vol. LXI, pp. 531-4 (1913).

[20]This conclusion is reached also by Ralston in his forthcoming paper, already noted. See also Comstock and Ashley, loc. cit.

crease in the viscosity of water with rising temperature is given in the accompanying table, the viscosity data being from the measurements of Hosking.[21]

The last column gives the percentage by which the viscosity decreases for each interval of 10° C. (18° F.). In most cases the corresponding increase in the rate of settling will be about in the same ratio, although exact agreement is not to be expected because of changes in flocculation, convection currents set up by the heating and other disturbing effects. The most important practical deduction from this table is that the effect of temperature change upon viscosity, and hence upon rate of settling, is greater at low temperatures than at high. For instance, the rise of temperature from freezing to 20° C. (68° F.) causes a nearly 44% decrease in viscosity and will probably increase the rate of settling by nearly as much. There are cases in which the use of waste steam to prevent chilling of slimes in winter will prove of important practical value, although heating above normal summer temperature is unprofitable.

It should be noted that the hastening of settling by increased flocculation is not always an unmixed blessing. The floccules formed by the particles have no great mechanical rigidity, but do persist in some extent in the settled material, with the result that a well-flocculated slime when thickened may have a larger pore space and greater volume per unit of dry matter than a slime that settled with a lower degree of flocculation. In those cases where the volume of the settled slime and the retention of solution in it are important and must be kept low, the engineer is confronted by opposing desiderata and must strike a balance between low flocculation, meaning slow settling with good consolidation, and high flocculation, meaning rapid settling with less perfect consolidation. This matter of the volume of the settled slime must not be confused, however, with the perviousness or imperviousness of the slime to percolating solutions. This includes a number of other factors which must be left for discussion in a later article. The hastening of settling by higher temperature does not necessarily involve changes in degree of flocculation and usually has no large effect on the volume of the thickened slime. What experience is available indicates that the volume is likely to be decreased.[22]

The Settling of Thick Suspensions

The discussion that precedes has assumed that single particles or single floccules were free to fall without interference from other particles in the same suspension. With dilute suspensions this is very nearly true, but the cases of most interest are the more-concentrated suspensions, in which particles are closely crowded. It is necessary to give some attention to the disturbances of the sedimentation relations thus created. The Stokes formula used in the preceding discussion is based upon a number of hydro-dynamic assumptions, among which is one that a single particle is falling through a fluid that is at rest.

It follows that the Stokes formula cannot be expected to apply exactly to ordinary slimes or other suspensions of considerable concentration in which many particles are falling simultaneously and close together. In attempting the analysis of these conditions it will be convenient to consider two special cases: First, the simultaneous fall of a number of spherical particles of equal size and specific gravity; and, econd, the fall of a single larger particle through a suspension of particles small enough to remain permanently suspended. The first case can be visualized as the fall of a group of equal-sized sand grains through a tube of water. If the sand grains are numerous enough relative to the diameter of the tube, the disturbance in the liquid created by each of them in its fall may be expected to interfere with the fall of adjoining particles and operate to increase the apparent or effective viscosity of the medium. The particles together will fall more slowly than one of them would fall alone.

Starting from reasonable assumptions, it can be shown mathematically that if the particles are of the same size, their rate of fall is lowered by this mutual impedence to a degree depending (between fixed limits) upon a power of the concentration between the first power and the square. By concentration we mean the ratio of the mass of the particles to the mass of the liquid or, since the particles are equal-sized, the number of particles per unit volume of the suspension. Increase of this concentration produces decrease in rate of fall, but in somewhat greater ratio. Suspensions of high concentration, such as thick slimes, will be expected to settle much more slowly than dilute ones, and it will be expected that a definite increment of concentration (expressed as a percentage of the initial concentration) will produce relatively more effect when the concentration is already high than when it is low. Continuous increase of concentration without flocculation will result relatively soon in a suspension that practically does not settle at all. Very dilute suspensions, on the other hand, will show relatively little response to limited increases of concentration. All of these conclusions are in substantial agreement with the experiments of Nichols[23] and of Mishler[24] on the settling of concentrated slimes, with the well-known experiments of Monroe[25] and of Richards[26] on the fall of particles in relatively narrow tubes, and with the experiments of Bardwell[27] on hindered settling, as well as with some experiments of Cameron and myself on the consolidation of thick kaolin suspensions, not yet published in detail.[28]

Important Considerations of Flocculation

More important in a consideration of flocculation is the relation between the mutual impedance of the falling particles and their size, the concentration of the suspension (relative to mass, not number, of particles) remaining constant. We are still considering, of course, groups of equal-sized particles. In this case mathematical analysis leads to the conclusion that the impeding effect will vary inversely as the square of the radius of the particle, and since the square of this radius already appears in the Stokes formula, it is apparent that the rate of fall in concentrated suspensions will vary (again between fixed limits) directly as the fourth power of the

[21] "Proc. Roy. Soc. New South Wales," Vol. XCIII, pp. 34-8 (1910).

[22] Salkinson, loc. cit.

[23] "Trans. I. M. M.," Vol. XVII, pp. 293-329 (1908); "Min. and Sci. Press," Vol. XCVII, pp. 54-6 (1908).

[24] "Eng. and Min. Journ." Vol. XCIV, pp. 643-6 (1912).

[25] "Trans. A. I. M. E.," Vol. XVII, pp. 637-59 (1889).

[26] Ib., Vol. XXIV, pp. 409-86 (1894). For more recent experiments, which are essentially confirmatory, see Jarvis, ib., Vol. XXXIX, pp. 451-521 (1908).

[27] "Trans. A. I. M. E.," Vol. XLVI, pp. 266-76 (1914).

[28] Abstract, "Science," (n.s.) Vol. XXXII, pp. 481-2 (1910).

radius. Now flocculation is essentially an increase of the effective radius of particle, and it may be expected, therefore, that a relatively small change in the degree of flocculation of concentrated slimes will produce a relatively large change in the rapidity of settling. The effect is in the same direction as in dilute suspensions, but is relatively much more marked.

Turning to the second case—the fall of a single coarser particle through a permanent suspension—it is manifest immediately that since the fine particles are in permanent suspension in the fluid, they will move with it and as a part of it and will produce no hydrodynamic impedance of the kind encountered in the first case. Any effect of the permanently suspended particles upon the fall of the larger one will result from an increase in the effective density of the medium or an increase in its effective viscosity as encountered by the larger particle. Obviously, the density effect will be continously and directly dependent upon the concentration of the suspension. It is probable, however, that the viscosity effect will be discontinuous and will show a sharp increase at that concentration at which the fine particles become so numerous and so close together as to touch each other or to bring into play the surface forces or so-called molecular attractions that begin to act as contact is nearly approached.

Impedance of Particles in Suspension

It may be expected that the fall of a coarser particle through a permanent suspension of fine particles will not be seriously impeded so long as the suspension is dilute. With more concentrated suspensions impedance will probably become serious at a relatively definite concentration the exact value of which will depend upon the size and nature of the fine particles. However, even below this critical value there will have been some slowing of the rate of settling due to increase in effective density of the medium. There appear to be no satisfactory experiments on these points. It is known that the viscosity of dilute suspensions is practically that of the medium, and there have been many studies of the viscosity of clay mixes and other plastics, essentially suspensions of very high concentrations, but the investigation of the viscosity of the suspensions of medium concentration encountered in ore dressing presents so many experimental difficulties that it seems not to have been undertaken seriously. The matter is so important to the theory of sand classification in the presence of slimes that it is to be hoped an effort will be made to unravel the phenomena.

General experience suffices for the statement that rate of fall and the precision of separations are greatly decreased by the presence of large amounts of fine slimes. An increase of flocculation, by decreasing the effective viscosity of the suspension, may facilitate the settling and separation of the sands. Frequently, however, this benefit is more than counterbalanced by the fact that floccules of slime particles behave like single larger grains and get into the sands. It is pointed out by Ralston[29] that it is frequently deflocculation which is practically useful in improving classification. If each particle is falling alone, the viscosity of the suspension may be higher and the fall of the larger grains less rapid, but there will be no contamination of the sand fractions by slime particles that got into the sands only because they fell as floccules and hence fell faster than their proper individual rates.

This discussion of two limiting cases of the behavior of concentrated slimes will suffice for indication of the controlling principles so far as these are known. Of course actual cases lie always between these extremes. Particles of the slimes encountered in practice are never all of one size, nor are slimes through which sand must be settled always of uniform particles or always in permanent suspension. Actual cases are beyond theoretical treatment at present and can be attacked only by specific experiment, in which experiment, however, the general principles of the simpler cases should serve as useful guides. Details of the available experimental data with especial reference to the practical problems of slime settling will be presented in a later article.

The Possibility of Selective Settling

In conclusion it is interesting to draw attention to an alluring hope—that of flocculating one mineral or group of minerals while other minerals or groups remain deflocculated. The essential problem of ore dressing is the separation of the valuable native minerals from associated minerals that are not of use. To this end are directed all the multitude of separation processes based upon differences in specific gravity, surface tension, magnetic susceptibility and other properties. Why should it not be possible to have a method of selective flocculation based upon a different response of ore and gangue to some flocculating or deflocculating agent or circumstance? Suppose, for instance, that the metallic mineral particles of a mixed suspension could be caused to flocculate, while the nonmetallic particles remained deflocculated. In the first draft of this article, written over a year ago, I wrote of this matter as something "which one hesitates to call a possibility, but which nevertheless seems not entirely fanciful." It is significant of present progress and future potentialities that the possibility that was so recently almost fanciful has actually been attained in at least one case. As a part of the work described in his forthcoming paper, Ralston was able to secure differential flocculation and settling of siliceous material from a certain slime with a considerable concentration of the values in the portion that remained suspended. I leave the details for his own presentation.

Similar possibilities appear to be involved in certain of Schwerin's patents,[30] and the use by natives of the Philippines of the extract of the plant *gogo* to facilitate the panning of gold is perhaps another case.[31] The practical possibilities of successful selective flocculation are obvious and are sure to lead to much investigation. Perhaps the fact that the valuable minerals are usually metallic and conduct electricity, while the useless ones are nonmetallic nonconductors, may furnish a further point of attack on the problem.

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[29] In his forthcoming paper already mentioned.

[30] German Pat. No. 249,983 (Feb. 1, 1910) also as British Pat. No. 2,379 (Jan. 30, 1911); German Pat. No. 253,563 (Jan. 26, 1911) also as U. S. Pat. No. 1,063,893 (1913); British Pat. No. 19,313 (1914). See also the patent of Lockwood and Samuel, British Pat. No. 6,148 (Mar. 19, 1908).

[31] Eddingfeld, "Phil. Jour. Sci.," Ser. A, Vol. VIII, pp. 135-9 (1913).

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Pig Iron Production in 1915

As stated in our preliminary review, Jan. 9, the production of pig iron, which started at low point in 1915, showed a rapid increase in the second half. For the first six months of the year, according to the completed and revised figures of the Statistical Bureau of the American Iron and Steel Association, the make of pig iron was 12,233,791 tons; for the second half it was 17,682,422 tons, making a total for the year 1915 of 29,916,213 gross tons, which is 6,583,969 tons, or 28.2%, more than in the preceding year.

The total production for two years past by grades of iron made was as follows:

Grades	1914 Tons	1914 %	1915 Tons	1915 %
Basic	9,670,687	41.45	13,093,214	43.77
Bessemer	7,859,127	33.68	10,523,306	35.17
Foundry	4,533,254	19.43	4,864,348	16.26
Malleable	671,771	2.88	829,921	2.77
Forge	361,651	1.55	316,214	1.06
Spiegeleisen	79,935	0.34	97,885	0.33
Ferromanganese	106,083	0.46	129,072	0.43
All other	49,736	0.21	62,253	0.21
Total	23,332,244	100.00	29,916,213	100.00

All pig iron and ferroalloys are included, whether made in blast furnaces or in electric furnaces. Pig iron made with bituminous coal is included under coke pig iron; pig iron made with mixed anthracite and coke is included in anthracite pig iron; pig iron made with coke and electricity is included in coke pig iron; that made with charcoal and electricity is included in charcoal pig iron. Low-phosphorus pig iron—that is iron running under 0.04 in phosphorus—is included in bessemer pig iron. Pig iron containing from 0.04 to 0.10% of phosphorus is classified as bessemer. The figures include under basic iron a small quantity of charcoal iron of basic grade. Nearly all the charcoal iron is classed as foundry pig iron. Ferrosilicon is included in foundry pig iron. Pig iron containing 7% or over of silicon is classified as ferrosilicon. Under all other grades are white and mottled iron, direct castings, and miscellaneous ferroalloys.

The production in 1915 according to fuel used was:

	1914 Tons	1914 %	1915 Tons	1915 %
Coke	22,976,856	98.5	29,535,308	98.7
Anthracite	91,464	0.4	84,753	0.3
Charcoal	263,924	1.1	296,152	1.0
Total	23,332,244	100.0	29,916,213	100.0

A very small quantity included under coke is made with raw bituminous coal or coal and coke mixed. Nearly all the anthracite furnaces use some proportion of coke, so that coke is practically the fuel for 98% of our iron. Of the charcoal iron made in 1915 only 5,302 tons was made with cold blast, the rest with warm blast.

Of the total production in 1915 there was 21,333,206 tons, or 71.3%, made by the steel-works furnaces for their own consumption, while 8,583,007 tons, or 28.7%, was merchant iron, made for sale. The merchant iron was largely of foundry and forge grades. The deliveries were: In molten condition, 17,108,891 tons, or 57.2%; sand cast, 5,076,469 tons, or 17%; machine cast, 6,969,108 tons, or 23.3%; chill cast, 740,413 tons, or 2.4%; direct castings, 21,332 tons, or 0.1%. The iron delivered in molten condition was nearly all basic and bessemer.

The production of pig iron by states for two years past was as follows:

States	1914 Tons	1914 %	1915 Tons	1915 %
Pennsylvania	9,733,369	41.72	12,790,668	42.75
Ohio	5,283,426	22.64	6,912,962	23.11
Illinois	1,847,451	7.92	2,447,220	8.18
New York, New Jersey	1,559,864	6.69	2,104,780	7.04
Alabama	1,826,929	7.83	2,049,453	6.85
Ind., Mich	1,557,355	6.67	1,986,778	6.64
Wis., Minn	329,526	1.41	372,966	1.25
W. Va., Ky., Miss	236,393	1.01	291,040	0.97
Mo., Col., Calif	267,777	1.15	271,921	0.91
Maryland	195,594	0.84	251,548	0.84
Virginia	271,228	1.16	251,346	0.84
Tennessee	216,738	0.93	177,729	0.59
Mass., Conn	6,594	0.03	7,802	0.03
Total	23,332,244	100.00	29,916,213	100.00

The number of furnaces in blast at the close of the year 1915 was 310, against 236 reported at the end of the first half-year.

The production for 15 years has been as follows, in gross tons:

1901	15,878,540	1906	25,307,191	1911	23,649,547
1902	17,821,307	1907	25,781,361	1912	29,726,937
1903	18,009,252	1908	15,936,018	1913	30,966,152
1904	16,497,033	1909	25,795,471	1914	23,332,244
1905	22,992,380	1910	27,303,567	1915	29,916,213

The production last year was the largest ever reported with the one exception of 1913. While it was nearly twice that of 15 years ago, yet it is to be noted that in 10 years past the gain has not been large.

A Bibliography of Flotation

A list of references on the subject of oil flotation has been published by the School of Mines and Metallurgy of the University of Missouri, Rolla, Mo. The preparation of this list was done by Jesse Cunningham, librarian.

The bibliography includes books, general works and magazine articles dating back to 1890, and while the librarian does not claim completeness for his work, it seems to include all the important discussions on the subject down to and including January, 1916. A number of articles dealing with colloid chemistry are included, as useful auxiliaries in the study of the subject. There is also a list of British and United States patents bearing on flotation.

February Mining Dividends

On page 449 of the *Journal*, Mar. 4, the Miami dividend was correctly stated at $1.25 per share, but inadvertently the total was given at only one-half the amount disbursed, which was $933,892. The United States Steel, preferred, rate was $1.75 per share; the total as stated being correct.

The Minimum Daily Water Consumption for domestic purposes according to data published on water supply systems in Catalog 7 of the Redwood Manufacturers Co., San Francisco, manufacturers of Remco redwood pipe, figures out 15 gal. per capita with a maximum of 40 and an average of 25 gal. per capita.

Field Fortifications, Sieges and Demolitions*

SYNOPSIS—The problems of field fortification, sieges and demolitions are for the engineer. Various kinds of trenches are defined and described, as well as the accessory features in front of and behind the fire trenches. The tools used by the troops and the tasks required of the men are enumerated. Under the discussion of sieges the underground work of the practical miner is followed in close detail. Military demolitions and military explosives are discussed.

Fortifications may be classified as permanent, semipermanent and field fortifications. Permanent fortifications are built in time of peace, by civilian labor, for the protection of the strategic points. The fortifications at Verdun on the French frontier are an example of this class. The United States has no permanent land fortifications; the nearest approach to such works are our seacoast forts. The term semipermanent fortifications is applied to works built for strategic purpose after the outbreak of war, which, owing to lack of time, are less elaborate than permanent fortifications. Works hastily constructed in the field by the troops themselves, to increase their fighting power, are called field fortifications. Sometimes hasty intrenchments begun on the field of battle gradually develop into elaborately prepared fortified lines until conditions approximating those of a siege exist. Such is the state on the western battle front in Europe today. This special case must not be taken to mean that all future operations in warfare will be confined to trench work.

Some Military Terms Defined

Before going into the subject of field fortifications, there are some military terms which should be understood. The parapet (see Fig. 1) is the earth thrown up in front of a trench for protection. The command of the parapet over any point in the foreground is the difference in elevations between its top and that point. The relief of the parapet is its elevation above the ditch in front, although the same term is often used to express its elevation above the bottom of the fire trench.

Fig. 2 represents a profile of a typical hill. The top is called the crest, and the break in the slope in front of the crest is called the military crest because from it all the country in the foreground can be swept. This cannot be done from the crest because there is a dead space at the foot of the hill caused by the military crest. This diagram also shows the cones of dispersion of shrapnel and shell and the difference in the depth of ground swept by the fragments on the front and reverse slope. A 3-in. shrapnel, at mid-range (3,000 yd.), on level ground will sweep a zone about 20 yd. wide and 250 yd. long. A 6-in. howitzer shrapnel at mid-range (3,400 yd.), will sweep a zone 25 yd. wide and 150 yd. long. The angle of dispersion of shrapnel is about 14°. The 4.7-in. shell used in our service is capable of inflicting serious damage over a radius of from 20 to 30 yd. from the point of burst.

*Excerpts from a lecture by Capt. Thomas M. Robins, Corps of Engineers, U. S. Army, delivered at United Engineering Societies Building, New York City, Feb. 28, 1916.

Hasty field intrenchments are constructed for tactical purposes. Superior fire effect is the chief object of all tactical operations, and the fullest scope must be given to the use of the gun, machine gun and rifle. Therefore, although the cover obtained by fortifications is of great importance in diminishing the effect of hostile fire, it must never interfere with the fire of our own weapons. Cover should afford as much protection as practicable against the enemy's projectiles of every kind, be inconspicuous and capable of easy and rapid construction with the means at hand.

The thickness of cover is a factor of the penetration of the projectiles to be used against it. For protection against rifle and shrapnel bullets 3 ft. of ordinary earth is required, for protection against light field-gun projectiles from 9 to 12 ft. of ordinary earth is necessary, and to resist the projectiles of heavy field guns a still greater thickness of cover must be provided. The penetration of the modern rifle bullet in various materials at a range of 400 yd. is as follows: Dry pine, 34 in.; dry oak, 25 in.; dry loam, 30 in.; gravel or broken stone, 9 in.; snow lightly compacted, 90 in.; brickwork, 15 in.

In general, troops will not be able to construct, with portable tools, cover strong enough to resist the fire of field guns. Protection against such fire must be secured by good concealment rather than by strength.

Profiles of Simple Trenches

The most effective use of a rifle necessitates a trench with a relief of about 4.5 ft. from the top of the cover to the surface upon which the soldier stands. A narrow trench 4.5 ft. deep, with the excavated earth carried away or scattered about in the vicinity, is the safest and most inconspicuous form. The best outlook, or command, can be obtained by throwing up a parapet 4.5 ft. high and letting the rifleman stand on the natural surface of the ground. This, however, gives poor concealment. For ease and rapidity of construction of a trench, it is evident that the cut and fill should be balanced. In practice a compromise must be made between these three forms so as to best fit the needs in each particular case.

Trenches must be placed so as to get a good field of fire. Modern firearms are effective at ranges over 1,000 yd., but the introduction of machine guns in large numbers, which can give an enormous volume of fire, has tended to reduce the extent of the field of fire formerly considered necessary. It is, however, believed that a clear field of fire of at least 600 yd. to the front should be obtained if practicable.

Trenches dug on the crests of hills afford the best view of the foreground, but give a plunging fire which is much less effective than a grazing fire, which could be obtained by a position lower down. It also gives poor concealment, and there is danger of dead spaces at the shorter ranges, which might afford shelter to the enemy. Prominent crests always form bad positions, affording a good target to the hostile artillery.

A trench position on gently rising ground with a concave slope gives a minimum exposure and a good view. Unfortunately, terrain is not made to order and it is

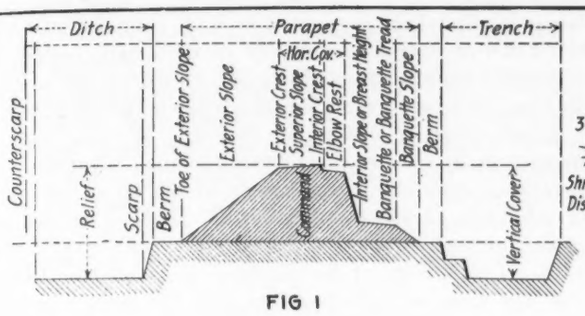


FIG 1

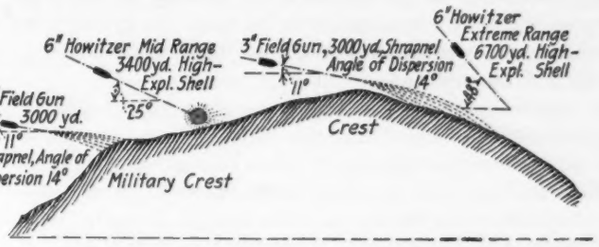

6" Howitzer Mid Range 3400 yd. High-Expl. Shell
3" Field Gun 3000 yd.
11°
Shrapnel, Angle of Dispersion 14°
25°
3" Field Gun, 3000 yd. Shrapnel Angle of Dispersion 14°
11°
6" Howitzer Extreme Range 6100 yd. High-Expl. Shell
Crest
Military Crest

FIG 2. Cone of Dispersion for Shell and Shrapnel

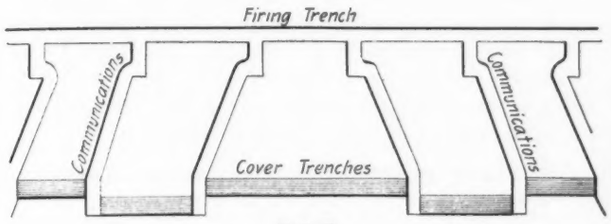


FIG 3

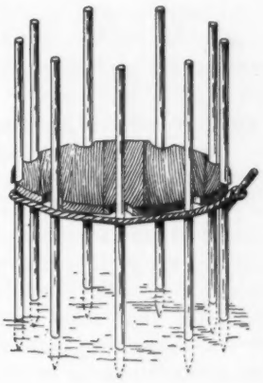


FIG. 4

FIG. 5

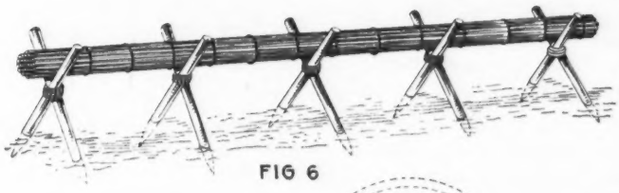


FIG 6

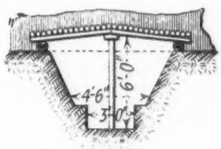


FIG. 7

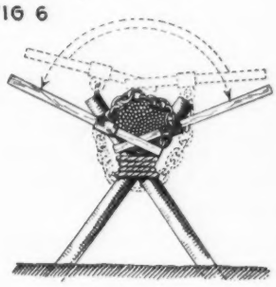


FIG. 8

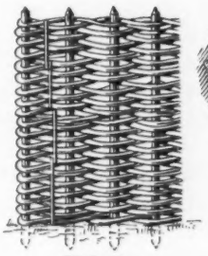


FIG. 9

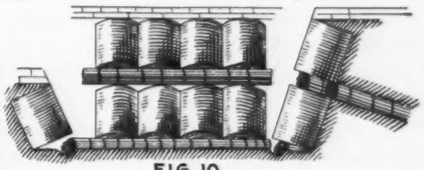


FIG. 10

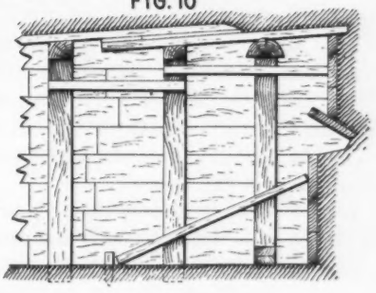
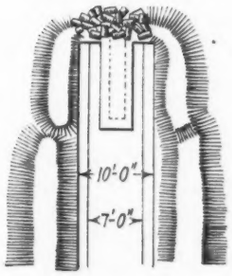


FIG. 11



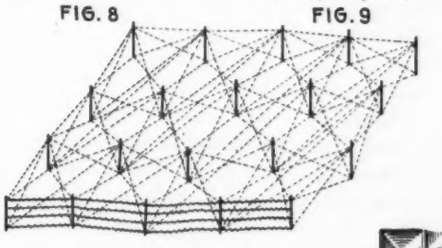


FIG. 13

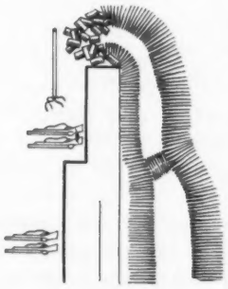


FIG 12

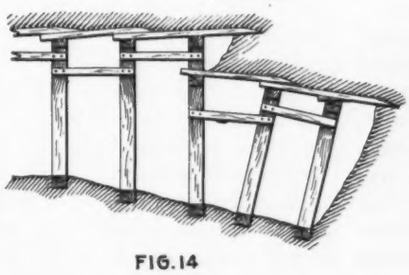


FIG. 14

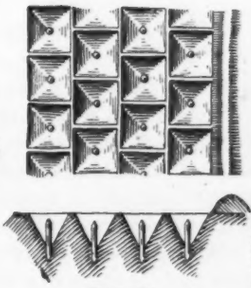


FIG. 15

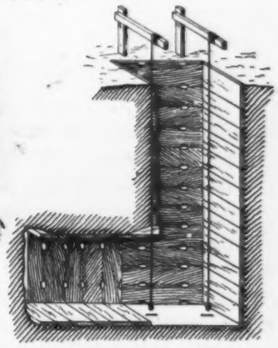


FIG. 16

SOME DETAILS OF THE MILITARY ENGINEERS' WORK ON THE FIRING LINE

generally necessary to choose between a position on a military crest and one farther forward. Positions forward of the military crest are less exposed to hostile fire, but make it difficult to communicate to the rear, either for bringing up reinforcements or to retreat. In laying out trenches, great care must be taken not to have them stand out against the sky line.

In order to avoid the effect of hostile artillery fire, it is understood that many trenches in the present war have been on the reverse slopes of hills. This greatly reduces the field of fire, but may afford marked advantages, especially in operations similar to those on the western front in Europe, where artillery is being used in overwhelming strength and trenches are fixed in position for long periods of time.

The considerations involved in the location of rifle trenches are so conflicting that everything must depend upon the judgment and experience of the officer responsible for laying out the position.

In practice, defensive lines usually consist of distinct defensive positions with intervals between them that are covered by cross and flanking fire. Such positions are known as supporting points.

Formerly it was thought that closed works in the nature of forts or redoubts were necessary for supporting points. Although such works are still used for the all-round defense of strategic points, they find little application today in battlefield fortification. They are difficult to conceal, and their protection from modern artillery fire is beyond the resources and time available in field operations. All the objects formerly sought by the use of redoubts with massive profile and geometric trace can be obtained better by a proper grouping of simple rifle trenches. In the rare cases where a closed work is necessary, it should take the form of a simple ring trench entirely surrounded by obstacles and will have a fixed garrison assigned to it.

A prepared fortified line will therefore normally consist of a line of supporting points or positions so placed as to defend the intervals by flanking and cross fire. The supporting points themselves may be natural topographical or existing artificial features (woods, villages, buildings, etc.) organized for defense, groups of rifle trenches or a combination of the two.

Long trenches are not desirable, even if the ground will permit, which is not ordinarily the case. It is preferable to limit the length of trenches to that needed for a company, and if additional length of front is required, to add more trenches of company, platoon or even squad length.

Use of Engineers in the Field

It is now accepted as a principle that all hasty field works must be constructed by troops who are to defend them, and all troops, infantry, cavalry and artillery are equipped with tools for this purpose. There are, however, many classes of work in the organization of a position which must be carried out by the engineers. These are: Demolitions for clearing the foreground and obstructing the movements of the enemy; cutting down heavy timber for which infantry tools are not suited; the construction of obstacles, substantial cover and special revetment; providing communications, especially bridges; the execution of special constructions, such as observation stations and shelters for the wounded; works on the second line of defense if one is contemplated.

The simple trench having been completed, there are various means of improving it with which accessory features engineers are especially involved. If it is evident from the first that there will be ample time, these additions will of course be included in the original plan, but ordinarily time is not available and improvements must be deferred until after a usable trench has been completed.

Head cover is ordinarily obtained by notching the parapet or by constructing loopholes in it. Notching the parapet is generally accomplished by the use of earth, sod or sandbags. Loopholes are usually made of sandbags or in the form of boxes of boards covered with earth or sandbags. The bottom of the loophole is called the floor, or sole, the sides are called cheeks, and the narrow part the throat. Loopholes made of plank and closed by steel plates about ½ in. thick with a slot through which the rifle can be used are very effective. Sometimes loopholes take the form of a continuous slot made by placing logs or fascines lengthwise on the parapet and supporting them at intervals with some suitable material.

Value of Head Cover and Short Trenches

Head cover is valuable for neutralizing shrapnel fire, but it increases the visibility of the parapet and restricts the field of fire. However, head cover should always be employed when practicable, as it affords more protection and increases greatly the accuracy of fire. Both notches and loopholes are largely used in the present war.

A long unbroken trench would be exposed to enfilade fire, and also a shell or shrapnel breaking in it would have a widespread effect. These difficulties can be partly overcome by constructing trenches in short lengths. They should, however, be further subdivided by traverses, when time permits. A traverse is a mound of earth placed at right angles to the parapet across the line of trench. The intervals between traverses should not exceed 8 yd. They should be about 1 yd. thick and not project above the parapet over 18 in.

On account of the accuracy of modern artillery fire it is essential, if trenches are to be occupied for any length of time, that some form of shelter be provided for the men when not actually manning the parapet. The overhead thickness of material for shelters will vary from 8 in. of earth on thin boards, for protection against shrapnel and splinters, to 3 ft. of earth on 6-in. timber, for protection against plunging fire from light field guns. It is almost always impracticable to provide overhead shelter against the high angle fire of modern heavy field guns and howitzers without resorting to measures that are ordinarily only practicable under siege conditions. A shell from a 6-in. howitzer will penetrate 21 ft. of earth before bursting. It will be effective against shelter consisting of 12-in. timber covered with 11 ft. of earth, and if the shell penetrates a bomb-proof and bursts, it is a foregone conclusion that everybody within 40 ft. of it will be killed by fragments and blast effect or be suffocated by the powder gases.

It is the general practice to construct in the fire trenches shelter against shrapnel only and to seek protection against heavy gunfire in rear of the fire trench, where the amount of cover that can be secured depends upon the time available in which to dig and the character of the soil.

Except when the garrison is actually required to man the parapet, it will remain under cover, leaving a few lookouts whose duty it will be to observe the enemy's

movements from observation stations. These should be carefully placed in order to get the maximum concealment consistent with their function, and provided with special overhead cover. Great use is now also made of periscopes and mirrors for observing the enemy at short range from the fire trench.

Machine guns are now a vital element on the battlefield. Provision for their efficient use must be made along the fire trench itself and also special emplacements constructed, which will afford the maximum protection practicable for the gun and its personnel. Splinter-proof overhead cover should always be provided if possible.

If a trench is to be occupied for any length of time, provision for drainage is essential. It has been said that "nothing so saps the courage of a soldier as to wet the seat of his trousers."

The floor of a trench should always be sloped to the rear, where an intercepting drain should collect the water and carry it to a point where it can be run off or to a sump where it can be pumped, baled, or otherwise disposed of. A sufficient supply of good drinking water must be assured to the men in the trenches. The way this will be done depends on the time and facilities available. Suitable vessels can be placed in the trenches and kept full. Special wells can sometimes be sunk or driven, and in rare cases pipe lines can be run, especially if the position is to be held for a long period of time.

In loose soils or sand great difficulty will be met in making the sloping sides of the trenches stand at the desired angles and a covering or facing placed on an earth slope to enable it to stand, called a revetment, should be resorted to whenever practicable (see Fig. 10). Sandbags make the best revetment because they can be easily replaced when damaged. Sod makes an excellent permanent revetment, but is not often available. Many ways of using poles, brush and plank suggest themselves, and they are quite effective. In general, the resourceful engineer will always be able to improvise some form of revetment from material at hand.

In Figs. 6 and 8 is shown the method of making fascines from brush or light poles, and one use of them is shown in Fig. 10. Gabions are constructed by weaving brush about a form, as shown in Figs. 4 and 9 and completed in Fig. 5. These are filled with earth, and their application to revetment is also shown in Fig. 10.

Accessory Features in Rear of Fire Trenches

It often happens that the character of the terrain is such as to afford natural cover for supports and reserves in rear of the fire trench. Such ideal conditions do not by any means always exist, and special provisions in rear of the line must be made for cover and for communications. Trenches for the protection of supports and reserves are called cover trenches, and those connecting the cover trench and the fire trench, communicating trenches. Fig. 2 shows a common arrangement of fire, communicating and cover trenches, and Fig. 7 shows a section of the latter.

Supports must be held near enough to the firing line to be able to readily reinforce it under all emergencies. This may compel cover trenches to be placed within 25 yd. of the fire trench, where it will be under heavy artillery fire aimed at the latter. Cover trenches differ from fire trenches in that their only function is to provide cover. While this must be made as good as practicable, ready means of egress from them to the front must always be provided.

Communicating trenches are intended merely for concealment of men when passing through them and therefore do not have to be as deep as cover trenches. They must, however, not be enfiladed and are therefore zigzagged to the front or heavily traversed. Several very necessary adjuncts, such as latrines and dressing stations, are usually placed in the communicating trenches.

Dummy trenches are frequently used to deceive the enemy and draw his fire. They should be made to simulate as far as practicable the real trenches, having just enough added conspicuousness to attract attention and carefully placed so that chance shots aimed at them will not hit our own men in the real trenches.

Easy communication must exist in rear of and along the position. Roads must be prepared, if they do not already exist, for the rapid movements of troops and supplies. Streams and ravines must be bridged or their banks cut down and otherwise made readily passable. Guide posts must be set up to guide the troops by day and lanterns to prevent them from losing their way by night. All these duties generally fall to the engineers. Telephonic communications are also important, but they are in charge of the Signal Corps.

Accessory Features in Front of Fire Trenches

In order that a good field of fire may be had to the front, it is often necessary to clear the foreground. Trees, woods, thickets, etc., must be cut down and removed, walls, fences and crops leveled, and depressions filled in. In short, everything that would interfere with our own fire or give shelter to the enemy must be done away with. The methods employed to accomplish this end are of course many, including the use of explosives, and in all of them engineers take an active part.

The function of obstacles is to retard the advance of the enemy and hold him under fire as long as possible. They are particularly useful when the field of fire is restricted. They also protect works from surprise. As a rule obstacles should be placed not farther away than 300 yd. and not nearer than 75 yd. Ordinarily, to prevent the enemy from slipping up at night and destroying our obstacles, they should be placed as near the interior limit as feasible. If practicable, obstacles should always be concealed and more or less protected from artillery fire according to the degree of concealment that can be obtained.

The most efficient obstacle is the barbed-wire entanglement (Fig. 13). To be effective a wire entanglement should be at least 30 ft. deep, although sometimes a strong wire fence will be found very useful to check the advance of raiding parties, etc.

An *abatis* is an obstacle presenting the sharpened ends of pronged timber to the enemy—like a tree felled toward the enemy and the leaves removed and all the branches sharpened. It has the disadvantage of affording some cover to the enemy and of easy destruction by artillery fire, from which it should always be protected by placing it in depressions when practicable.

Military pits (Fig. 15) are deep cone-shaped holes dug in the foreground, having sharp stakes driven in the bottom to impale men falling into them. Military pits in combination with barbed-wire entanglements were used with good effect in Manchuria. The Filipinos also em-

ployed them against our troops, covered over and concealed by brush.

Another form of obstacle sometimes used is the *cheveaux de frise.* It consists ordinarily of a number of sharpened timbers put together in sawbuck fashion. Sometimes iron spikes are used instead of timber, and often barbed-wire is strung on it in order to reduce the number of lumber prongs. The *cheveaux de frise* makes a convenient portable obstacle.

The illumination of the foreground at night is an important duty of the engineers. When effective illumination of the foreground is impracticable, men must be placed in observation to the front at night. Shelter must be provided for these men both from the fire of the enemy and the fire of our own troops, because they will not be able to retreat after giving the alarm.

Execution of Field Fortification by Troops

The ability to prepare cover quickly and under all emergencies is now regarded as so important that work tools form a part of the portable equipment of troops, from which the soldier is never separated and which is second in importance only to rifle and ammunition.

In order to reduce weight and to admit of greater convenience in carrying, the portable-tool equipment is considerably lighter than the corresponding commercial tools, which necessarily reduces the output of work. The portable-tool equipment of our infantry (tools carried on the person of the soldier) is as follows for each squad of 8 men: 1 pick mattock, 1 wire cutter, 3 shovels, 1 cutting tool (hatchet or machete).

In addition to the portable tools, additional tools of larger size and special pattern are carried in the combat and field trains for use in the more comprehensive organizations of the forces. The following outfit of such tools (called pack tools) is carried in the divisional engineer trains for each regiment of infantry: 26 axes, 7 crowbars, 95 lb. nails, 149 pick mattocks, 450 sandbags, 13 handsaws, 13 two-man saws, 298 shovels, 25 lb. of wire, 1 carborundum wheel, 1 saw set (for handsaws), 1 saw tool (for two-man saws), 6 saw files.

The equipment just enumerated is carried on one escort wagon, and the engineer train made up of these wagons is in charge of the chief engineer of the division. This is entirely distinct and separate from the special equipment pertaining to the engineer companies.

In the construction of rifle trenches, the company forms the normal working unit. The company commander, assisted by his lieutenants and noncommissioned officers, marks out the line of the trench and determines the height of parapet and the situation of traverses. The men are then deployed along the line, posted at the proper intervals and go to work.

If an attack is likely during the progress of the work, first efforts should be directed toward securing a parapet of sufficient height to afford cover for the head and a support for the rifle in a lying-down position, after which the trench is gradually deepened to a standing trench.

Each man is ordinarily assigned a certain task or amount of work to do, after the completion of which he is relieved. When the amount of work is such that it cannot be completed by assigning a definite task to each available man, the men are divided into reliefs, each relief working for a stated period of time. To get the best results, a task or relief should not exceed two hours.

The time required for the execution of the different classes of work involved in hasty field fortifications depends upon the tools used and the character of the soil. The output of men working with portable tools is about ⅗ of that when the pack tools are used. Experience has shown that the average output per man per hour in medium soils with pack tools is about 20 cu.ft. The most important fact to remember is that a simple standing rifle trench can be constructed in two hours or less with portable tools and that two hours' additional work with the same tools will convert this into a complete standing trench.

Defense of Line of Communications

The uninterrupted service of the line of communications is of vital importance to the existence of an army. When the lines of communication are long, it will manifestly be impracticable to assign troops throughout their entire length. Attacks on lines of communication will generally take the form of raids against its vital points—important bridges, viaducts, tunnels, locks, etc. In enabling a defense to be made of these points with relatively small forces, field fortification plays an important rôle

The attack by regular approaches of a strongly fortified place involves mainly the principles and devices previously considered, but their employment is under conditions radically different from those resulting from the contact of two mobile armies, which leads to many modifications in fortification work as it is carried out in the field.

The differences referred to are principally as follows: Guns of heavier caliber will be encountered; the terrain being well known to the defense; all fire will be more accurate; high-angle fire will be extensively employed, and angles of fall of 30° and greater may be expected; some trench work must be executed and gain ground to the front under heavy fire; mining operations must ordinarily be resorted to.

The First Step in Siege Operations

The first step in the reduction of a fortress or fortified camp or area is to cut off communication by surrounding it with a line of troops beyond the range of artillery. Such a line is called the line of investment. Troops are assigned to each sector of the line of investment and begin to put it in a condition for defense. The time that must ordinarily elapse before siege material can be brought up will permit a great deal of such work to be done.

The real attack is pushed inward from a few points only along the line of investment—usually two. The side on which these attacks are made will be determined by the following conditions: The best communication with the base; the best terrain for battery positions and approach under natural cover; the most favorable ground for siege railways; the easiest digging; the most important consequences of success.

When the front of attack is decided upon, a site is established for the main engineer park, out of reach of the defenders' artillery, convenient to the front selected and the lines of supply, and the engineer material necessary for the siege stored in the park as fast as it arrives. Sites for the main siege batteries are next selected at moderately long range from the forts and connected by a belt of siege-railway lines.

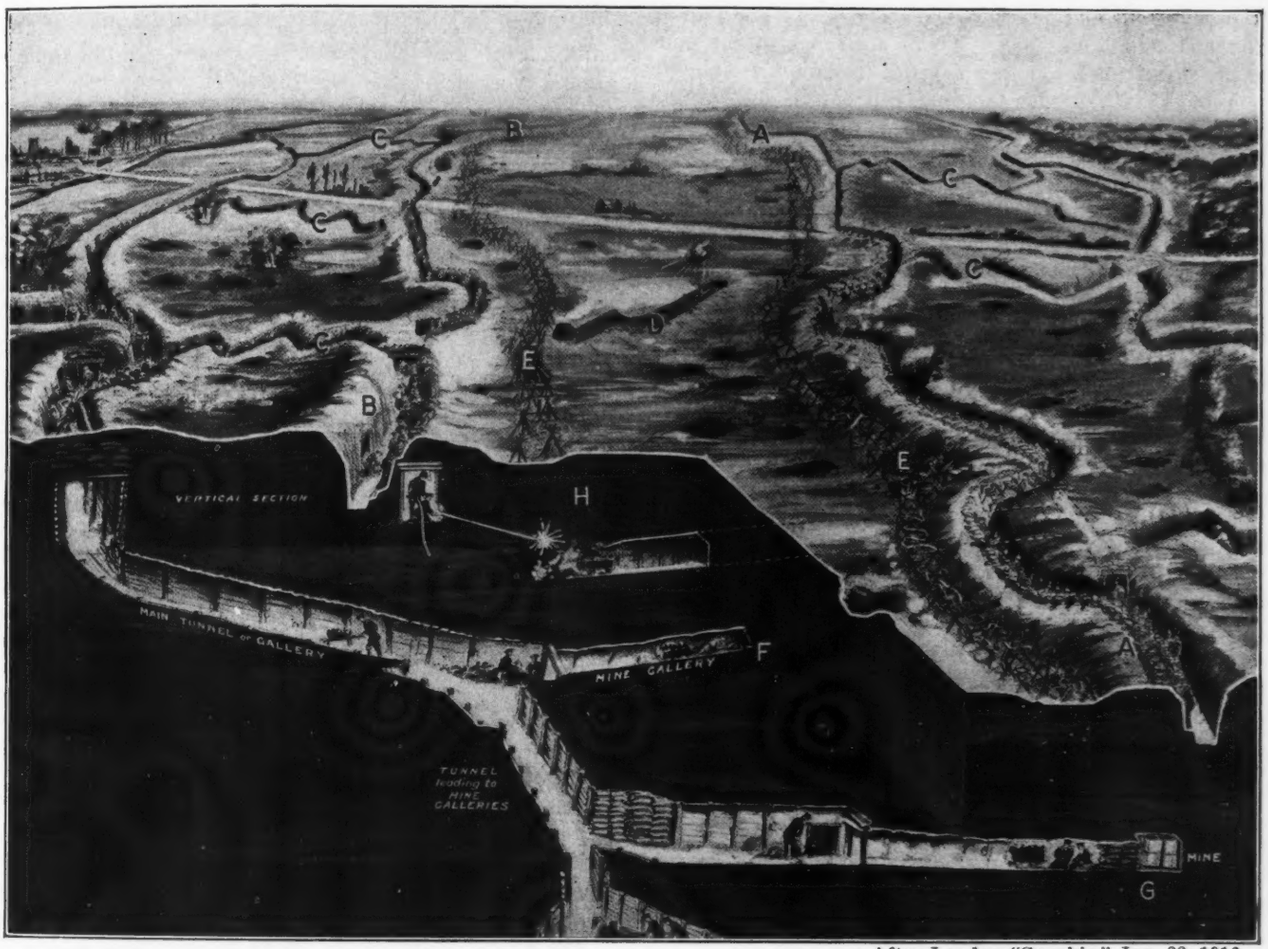
When the siege batteries have brought the defenders' artillery under control, the first attempt to gain ground

to the front is made by opening a trench, generally parallel to the line of investment and if possible within 1,200 yd. of the enemy's main line. This trench is usually established at night under cover of a determined attack, and is called the first parallel. Approaches or zigzag communicating trenches must be dug the same night, connecting the first parallel with cover to the rear.

The first infantry position, or parallel, being established, a second one, well-advanced, is the next objective. The second parallel should be about 500 or 600 yd. from the enemy's works. Sometimes the second parallel and its communicating trenches with the first can be established at night, like the first parallel and its approaches, but ordinarily by digging the approaches under fire, progressing from one end (see Fig. 12). This operation is called sapping, hence the term sapper, and is generally the work of engineers. The dirt is thrown to one side in the usual way, and protection is afforded at the end of the trench by a pile of sandbags which are rolled ahead by using a fork, as the digging progresses. Double saps, as shown in Fig. 12, may be used for better protection, the traverse being removed later. When the zigzag approach trenches have been driven by sap to the required distance, the second parallel is broken out—all in the same night if practicable. Successive parallels are established in the same manner until the besiegers can launch a successful assault, combined with mining operations to blow up the enemy positions and breach the intrenchments.

In the final stages of a siege, mining operations are resorted to in order to breach the enemy's work and make an assault practicable. The enemy will promptly start countermines, and a prolonged underground warfare results, each side trying to blow in the other side's galleries before a mine can be planted under their works.

The methods of mining generally used are similar to ordinary tunneling or mining operations in earth, except of course on a much smaller scale. Galleries approximating 7 ft. in width by 6 ft. in height are generally the largest used. They constitute the trunk lines from which much smaller galleries branch out. The method of timbering and supporting these galleries is the same as used by everyday miners, as will be seen from Figs. 11-14. Fig. 16 shows the method of cribbing a shaft to get down to the required depth for gallery driving to the enemy lines.



After London "Graphic," Jan. 22, 1916

PART PLAN AND SECTION OF BATTLEFIELD IN MODERN TRENCH WARFARE

Military demolitions, to destroy or make unserviceable any object in the theater of war the preservation of which will be unfavorable to our army or favorable to the enemy, are permissible only in case of military necessity and are generally undertaken only at the direction of higher commanders. They are generally carried out by the engineers, particularly those involving the use of explosives.

In handling, priming and firing explosives for demolition purposes methods similar to those used in mining-engineering practice are employed. Bickford fuse is used in ordinary work. For firing a large number of charges simultaneously, magnetos and electric fuses are used. In

demolitions made with outfits carried on pack mules, instantaneous fuse is used for simultaneous charges because a firing battery is too heavy to carry around.

Many kinds of explosives have been tried for demolition work, including dynamite, guncotton, rackarock, etc., but all of them have some objectionable features. Trinitrotoluol has been developed by the Germans into a very satisfactory military explosive and has now been adopted for our army. It is used in the crystalline form compressed into blocks or sticks. Its insensibility varies directly with its degree of compression. The density specified for our service is about 1.4. Even this is too great for satisfactory detonation with ordinary commercial caps.

The blocks of trinitrotoluol used in our service are 1¾x1¾x3 in. and weigh ½ lb. The sticks are 1¼ in. diameter and 3 in. long. There are holes in the ends of the blocks and sticks in which the detonators are placed.

A block with proper tamping will cut its own length of steel plate 1½ in. thick, a 90-lb. rail, 12 in. of reinforced concrete, or 18 in. of ordinary masonry. A stick will cut a 10-in. timber if placed in a central hole.

The caps used in our service are made by a secret process. They probably consist of lead azide (PbN_6) with a boosting charge of trinitrotoluol. They are very powerful and have to be carried in special boxes with a padded hole for each cap.

The instantaneous fuse now adopted for our service consists of a lead tube filled with trinitrotoluol. It burns at the rate of 5,400 m. a second. It is always used with caps, but itself will detonate a block under favorable conditions.

The means that may be employed to carry out demolitions without explosives are many and too simple and apparent to require explanation; wire entanglements when not destroyed by artillery fire must always be cut by wire cutters into small pieces.

The accompanying illustration shows partly in plan and partly in section the field of operation of mining engineers in modern warfare. *AA* and *BB* represent the fire trenches filled with men, with supporting trenches generally paralleling them in the rear, and connected with the fire trenches by the zigzag communication trenches *C*, zigzagged, as previously stated, for the purpose of preventing enfilade fire. In front of each line of fire trenches are the barbed-wire entanglements *E*.

At *D*, between the two lines of fire trenches, is a sap. This was started as an underground drift from one line of fire trenches, and emerging to the surface somewhere between the two lines, zigzags toward the enemy trench a sufficient distance to enable the soldiers to throw bombs and hand grenades into the enemy's fire trench.

In the sectionalized part, *F* shows an ordinary mine heading being driven ahead; *G* shows a mine loaded with explosives underneath the enemy's trench, tamped with a thick heading of sandbags, nearly ready to be exploded. At *H* is shown the use of the camouflet; where one side, by means of the listening post, microphone or some such means, has detected the approach of an enemy trench and has drilled a hole into the enemy workings and exploded therein high explosives with disastrous effect to the working crew.

I have freely quoted from the "Engineer Field Manual" and "Notes on Field Fortification" compiled at the Army Field Engineer School at Fort Leavenworth, and the illustrations shown are taken from these publications.

The Sunset Property at Rhyolite

By Edward S. Van Dyck*

The mine and mill of the Sunset Mining and Development Co. are at Rhyolite, Nye County, Nev., in the Bullfrog mining district. The mine was one of the producers of high-grade ore during the boom days of the camp, when there were no mills for local treatment and all ore was shipped out to smelters. At that time and on the grade of ore then being extracted, it was not at all unusual for marketing expenses alone to exceed $100 per ton. It is a far cry between the costs of those days and the costs of today, when less than $4 per ton pays everything, starting at the stope and ending at the bullion bar. The vein system is extensive, and the underground workings total over 15,000 ft.

The scheme of development followed by the present management is to drive the main, or haulage, tunnel the full length of the mineralized area (3,000 ft.) and to tap all veins from this tunnel. The tunnel has now reached a length of 2,200 ft., and all the veins except one have been connected. This last connection will be made in about eight months. The backs above the tunnel level range from 400 to 800 ft. When the tunnel is completed and connections made, two shafts, one on the Tramp vein and one on the Denver vein, will be sunk.

At the present time ore is being extracted from five stopes. The ore is broken with machine drills and the shrinkage system of stoping is employed, thus minimizing timber costs. All ore is trammed to one storage stope, the longest man tram being 100 ft. It is taken from the storage stope to the mill by mule train.

The milling plant is situated at the mouth of the main tunnel, the millsite having a sufficient grade to admit of an all-gravity system. Ten 1,050-lb. stamps are used, equipped with 8-mesh screens. Cyanide solution is introduced at the stamps. The thickened pulp is agitated in four Pachuca agitators and finally filtered in a Portland filter. Tailings are carried out by means of a belt conveyor.

The mill treats slightly more than 50 tons per day at the preesnt time, owing to lack of crushing capacity, but this is being remedied and the tonnage will be increased to 100 per day. The latest mill reports show an extraction of 93% on a consumption of 0.6 lb. of cyanide per ton of ore treated.

The following tabulation shows the operating costs per ton:

MINING

Labor	Power	Explosives	Timber	Assaying and Surveying	Miscellaneous	Total
$0.974	$0.083	$0.198	$0.022	$0.077	$0.081	$1.435

MILLING

	Assaying	Crushing	Agitating	Filtering	Precipitating and Refining	Total
Labor.....	$0.077	$0.238	$0.143	$0.166	$0.064	$0.688
Power.....	.....	.608	.183	.041	.....	.832
Supplies....	.048	.226	.343	.056	.113	.786
Total....	$0.125	$1.072	$0.669	$0.263	$0.177	$2.306

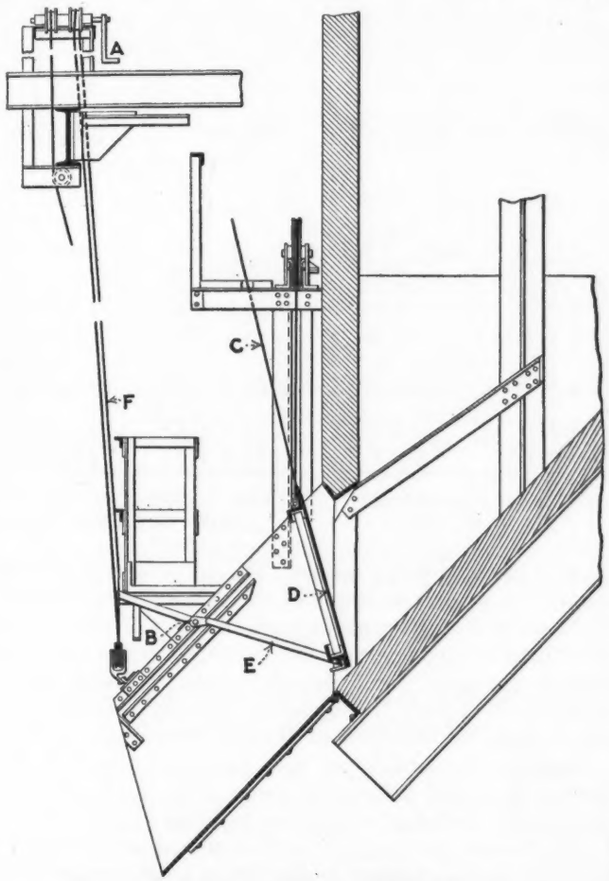
The total for mining and milling is $3.741. Seventy-five cents per ton is now allowed for development. It is estimated that on a 100-ton per day basis $2.50 per ton will cover mining, milling and development.

*President, Sunset Mining and Development Co., 265 Russ Building, San Francisco.

Details of Practical Mining

Door-Operating Mechanism for Ore Bins

A United States patent, No. 1,164,702, Dec. 21, 1915, has been granted to Leland Clapper, of Two Harbors, Minn., for an ore-bin door-operating mechanism whereby ore-bin doors may be operated and controlled from the deck of an ore dock. As docks are at present constructed, the vertical height from the deck, where the cars are unloaded, to the discharge opening in the bin is approximately 35 ft. At present the operating mechanism is controlled adjacent to the door. For reasons of safety



ORE-BIN OPERATING DEVICE

to the operator and for operating economy, the patentee claims that it is very desirable that the doors should be operated from the deck of the dock.

The operation of the device is as follows: Assuming the parts in the positions shown, by rotating the crank *A* the latch *B* is, by means of the cable, moved to an inoperative position. At the same time the cable *C* assumes a position more nearly taut, but not entirely so. Latch *B* being now inoperative, the door *D* swings outward under the weight of ore pressing against it. After the door has swung outward, the crank *A* is moved longitudinally and rotated, whereupon the door is lifted out of the path of the ore. This moves the strut *E* to a position above the latch *B*. Just prior to the point of the complete elevation of the door, the short cable *C* becomes taut and pulls upon the cable *F*, thus causing latch *B* to be restored to its original position. When the door is lowered, short cable *C* is inoperative and simply hangs in a loop, while latch *B* remains in position to engage the other end of strut *E*. All this may be accomplished from the deck of the dock, without the attendant danger of operation from the platform along, and in front of, the bin.

Sinking the Woodbury Shaft*

The Woodbury shaft sunk by the Newport Mining Co., at Ironwood, Mich., is vertical, with its length at right angles to the strike of the formation. The over-all dimensions are 13 ft. 1 in. by 21 ft. 1 in., having six compartments, which will accommodate 2 skips, 2 cages, 1 ladder road and the necessary piping.

The first 100 ft. of sinking was in quartzite; from 100 ft. to 715 ft. was in alternate strata of gray and red slates and quartzite. Below this is granite.

During the sinking of the first 700 ft. practically all of the hoisting was done in 3 compartments by means of a single-drum hoist. The air line, which is a 6-in. wrought-iron pipe, is for permanent use.

The drilling equipment for sinking is in some respects different from that used in ordinary practice. First of all, the "header," shown in Fig. 1, distributes air to the machines. A single machine is shown hanging in position, out of the way when not in use. When ready to drill, all that is necessary is to remove the drill from the hook and pull downward, the counterweight *F* keeping the slack hose out of the way while drilling. *A* is a casting 9 in. in diameter, bored out in the center and having a bolt circle of a standard 4-in. flange.

Eight holes evenly spaced are drilled in the sides and tapped for ¾-in. nipples, to which the machine hose connections are made. *B* is a duplicate of *A* with the exception that the holes for the nipples are of different size. There are seven ½-in. connections and one 1-in., the latter being an inlet for the water and the others for water discharges to the drills. The hooks, or hangers, marked *C*, are made of ⅜x2-in. strap iron. There are four straps with a hook on each end. *A*, *B* and *C* are held together by four ¾-in. bolts passing through the 4-in. flange at the bottom of the 4-in. air pipe *E*. The ell at the top is made specially, with a lug cast on it to accommodate the 1-in. eye-bolt by means of which the "header" is suspended. *D* is a 9-in. pipe which serves as a casing to inclose the counterweights *F*. Two of these headers are used. Each will accommodate seven jackhamers and one blowpipe, but only six machines are used on each at present. When not in use the "headers" are hung off to one side in the headframe and can be easily

*Excerpt from paper by J. M. Broan, mining engineer, Newport Mining Co., presented at the twentieth annual meeting of the Lake Superior Mining Institute.

lowered by means of a sling beneath the bucket. While in use they hang on a small chain-block fastened to the bottom shaft set. By means of this chain-block the apparatus can be brought to any desired height, the adjustment being allowed by the use of a 3-in. air hose *H*, which connects to the air main, the bottom of which is always far enough up the shaft to avoid any severe blows during blasting. One of these outfits can be taken from its position on surface and placed on the chain-block below ready for drilling in less than five minutes,

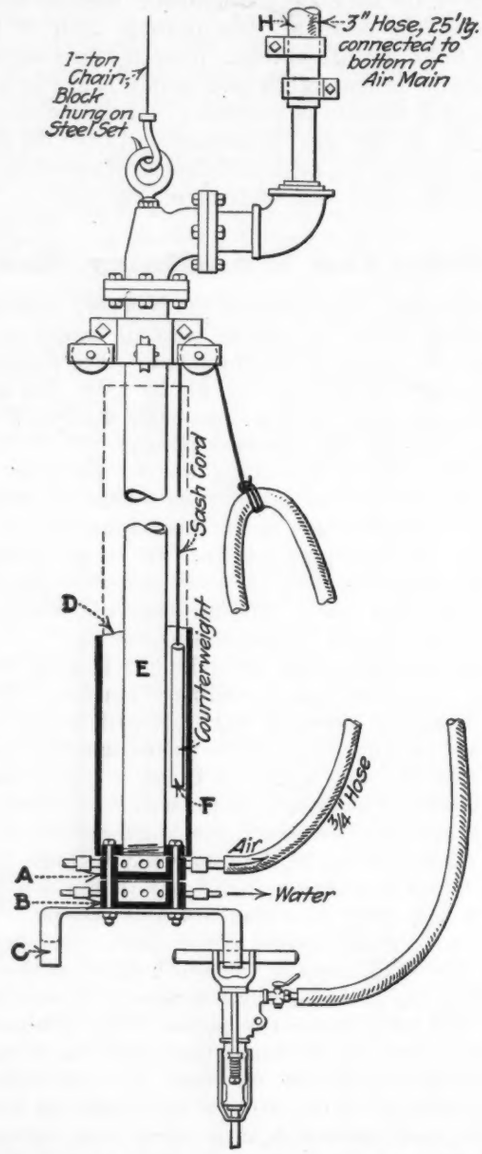


FIG. 1. HEADER FOR MULTIPLE HAND-HAMMER DRILLS IN SINKING

only one connection being necessary. The steel, which was ⅞-in. hollow hexagon, is made up into lengths varying by 1-ft. changes from 12 in. to 10 ft., with a ⅛-in. difference in gage for each drill, the first bit being 2¼ in.

Until the granite was reached, the four-point or cross-bit was used, but the wear on the gage became such as to warrant a change if something more serviceable could be found. Then the Carr bit was tried out. Considerable difficulty was encountered, especially in the stratified rocks with fissured holes and stuck drills. While in the soft slates, 10-ft. drills were used with little difficulty, and sinks measuring as deep as 9 ft. have been blasted successfully. About 470 lin.ft. of drilling was required per cut in these slates, and this could be completed in from 4 to 5 hr. In the hard quartzite, dike and granite the gage on the steel would not hold up long enough to permit the use of any drill over 8 ft. long.

In these rocks about 425 lin.ft. of drilling is necessary, which can be drilled in from 7 to 8 hr. The breaking of the holes is dependent entirely upon their arrangement and the order in which they are fired. Fig. 2 shows the plan and section of the arrangement and the order of firing used while in soft slates. Line *AA* represents a bedding plane on which the rows Nos. 1, 2 and 3 on the right were bottomed. The shaft was blasted in two separate blasts, the first being made on the right, and the holes were blasted in the order numbered in the plan. Three holes marked No. 1 were fired simultaneously with No. 6 electric blasting caps. The exploders in the remaining holes were made up of No. 8 caps and electric delay fuse igniters.

A different arrangement of drilling and order of firing has been found more satisfactory in the granite. Fig. 3

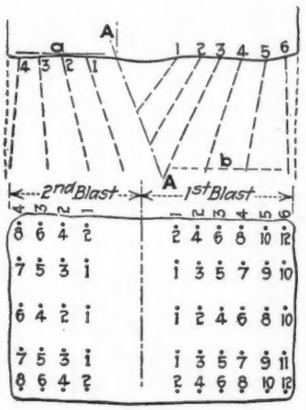


FIG. 2. DRILL ROUND FOR SLATE

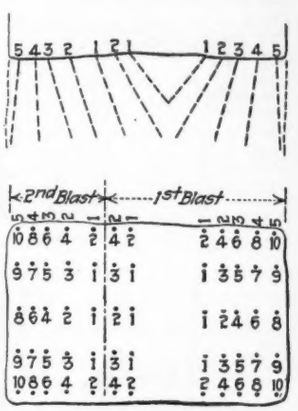


FIG. 3. DRILL ROUND FOR GRANITE

shows 2 rows of holes marked No. 1, which are drilled about 5 ft. deep at an angle of 60°; then 2 rows marked No. 2 about 8 ft. deep at an angle of 70°. These 4 rows of 5 holes each comprise the cutting holes, which are fired in the order numbered in the plan. The 6 No. 1 holes are fired with No. 6 electric blasting caps and the others with No. 8 caps and electric delay fuse igniters.

Since the steel used was only ⅞ in. in diameter, the bottom of a deep hole is of course very small and cannot contain sufficient explosives to break the burden in a satisfactory manner. To offset this disadvantage as much as possible without drilling more holes, two or three sticks of 100% blasting gelatin is placed in the bottom of each hole. The remainder of the charge, with the exception of the cartridge containing the detonator, is 80% blasting gelatin. Experiments by the du Pont people have shown that 60% nitroglycerin gives a maximum efficiency for speeding up the action of a charge, and for this reason a single cartridge of this strength is used to contain the detonator. It is placed as near the top of the charge as considered safe from being cut off by the breaking of an adjacent hole. Cartridges of sand are used for tamping. An average of 26½ lb. of explosives per ft. of shaft was used in the first 800 ft., or about 1 lb. for every 13 cu.ft. of excavation.

After a blast the smoke is cleared away by means of a draft forced through a 12-in. pipe by a 7-hp. fan, on the surface. At first the fan was used to draw the smoke out, but by reversing the air current a marked advantage was noticeable in the time required to clear the smoke.

During the first 700 ft. of sinking the rock was disposed of by means of three buckets having a capacity of 26 cu.ft. each. In order to make shoveling as easy as possible, steel plates have been used as sollars, with considerable success. In Fig. 2, *a* shows the position of these plates when the first blast is made. The breaking of the holes in this blast has a tendency to throw the rock to the position of the plates. In the second blast of the same cut the plates are placed in position *b*.

During the mining operations below, the construction crew is employed placing sets, ladders, etc., above. The steel sets are made of 6-in. H sections (23.8 lb.), hung on studdles made of 3x5-in. angle iron. Sets are spaced 6 ft. centers in the slates and 8 ft. centers in the granite. At about every 100 ft. of shaft a bearing set is placed under the shaft set. There are 5 men on the crew that places these sets. These men can hang a set and put in the wooden lath in an 8-hr. shift. On the second and third shifts there are construction crews of three men each, who place guides, ladders and sollars and complete any work the first crew may have left undone.

Guides are made of 6x7-in. pine, dressed, and are framed to span two 8-ft. sets or three 6-ft. sets. Lath for lining the shaft are made of 2-in. hardwood. These will also serve as forms for concreting when sinking operations are completed. The ladders are made of ⅜x2-in. strap-iron sides and ¾-in. iron rungs. They are long enough to reach over two 8-ft. sets or three 6-ft. sets, and in both cases have about 4 ft. projecting above the sollar. The sollars are made of 3-in. plank.

The men employed in the shaft are as follows: One shaft captain, 3 shift bosses, 36 miners, 11 construction men, 1 electrician, 4 landers, 2 motormen, 4 hoist engineers—a total of 62 men.

The maximum footage per month was 201 and the minimum 173 ft. for the first 5 months, during which 901 ft. was sunk.

Drilling Methods in Driving Six-Foot Tunnel*

One element of the new sewage-disposal system for Portchester, N. Y., is a tunnel 900 ft. long and 5x6 ft. in cross-section, in granite. In driving the tunnel, hand-hammer drills were employed, mounted on the crossarms of a center column, as illustrated in Fig. 1. The advance averaged 200 ft. per month of 25 working days, the record month being 210.5 ft.

Fig. 2 is a diagram of the round. No. 1 drill, on the upper arm, puts in holes 1 to 9 in the upper half of the heading, and No. 2, on the lower arm, drills holes 1-A to 8-A. No. 2 drill, as a rule, has one less hole to drill than No. 1, owing to a mere awkward position. Two drillrunners, a nipper and two muckers constituted the tunnel crew for each shift.

Holes 1-A to 8-A in the lower half of the heading were loaded first and fired together; then holes 5, 8 and 9 in the upper half and, lastly, holes 1, 2, 3, 4, 6 and 7. All holes were bottomed at 1⅝ in., 1¼-in. powder being used.

*Excerpt from article by S. W. Symons, 388 Henry St., Brooklyn, N. Y., in "Engineering News," Feb. 24, 1916.

FIG. 1. HEADING OF PORTCHESTER SEWER TUNNEL, SHOWING MOUNTING OF DRILLS

The average footage was 4 ft. per round, but when the tunnel broke high, allowing the use of a 6-ft. steel for holes 3-A, 4-A, 7-A and 8-A, as much as 5 ft. could be pulled. The total time for drilling the round, which included removing the heading muck far enough back to set up the drill column, amounted to from 4 to 5 hr., the loading and shooting consuming about 3 hr. Water, when encountered, was handled by a simple steam siphon. Drill steel was sharpened by hand. Crossbits were used.

Track was laid to within a few feet of the heading, to facilitate mucking operations. The muck was loaded into a bucket set on a truck, pushed by hand to the shaft, the bucket hoisted to the top and the muck dumped close beside the shaft.

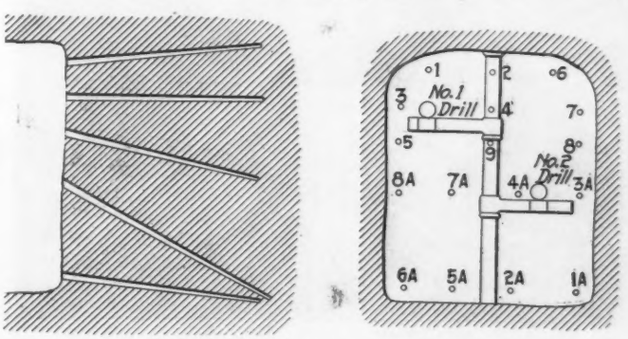


FIG. 2. LOCATION OF HOLES FOR DRILL ROUND

The powder used was gradually reduced to 10 lb. per yd. of solid material—approximately 10 lb. per ft. of advance. The rock, for the most part, broke rather small for economical handling, but this was to be expected, owing to the small size of the tunnel and the necessarily close spacing of the holes. The dynamite was 60%.

Details of Milling and Smelting

An Automatic Pulp Sampler

By Robert B. Elder*

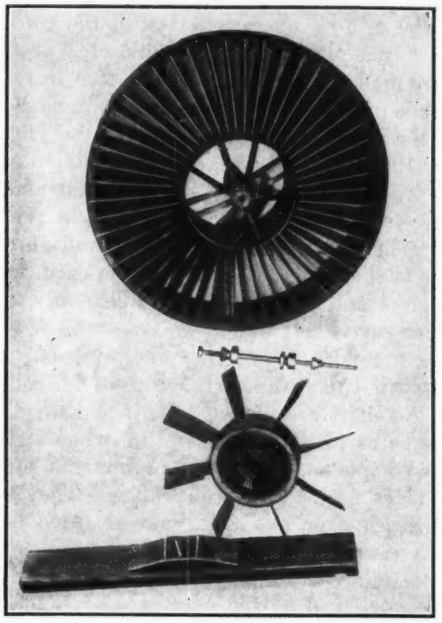
The essential ideas for the construction of the sampler herewith described were obtained from the description of the Borcherdt sampler.[1] This is a device for sampling a stream of pulp. It cuts the sample by means of a wheel having a large number of vanes, or spokes, of sheet steel. These vanes are equally spaced and the plane of each passes through the axis of the wheel, so that they form a corresponding number of equal chambers or pockets in the wheel. The wheel is mounted on ball bearings, revolves in a horizontal plane and the entire stream of pulp to be sampled is run through the chambers of the wheel in such a manner as to cause it to revolve. All the chambers of the wheel are open except the one that catches the sample, and it is made to discharge at the bottom center of the wheel into a pipe placed vertically beneath the wheel so as to deliver the sample into a suitable container. To quote from the description:

> As will at once be evident, the whole machine is simply a crude form of turbine in which the pulp to be sampled furnishes the motive power, and as all the pulp is discharged through the wheel and as all of the cells are equal and open save one, it follows inevitably that the single closed cell, or bucket, catches and conveys away its definite proportion of the whole pulp, regardless of the quantity of the pulp (within the limit of the capacity of the sample bucket), the speed of the wheel or the number of pipes delivering the pulp.

The proportion of material cut into the sample depends on the number of chambers in the wheel. With 100

INSTALLATION OF THE SAMPLER

chambers a 1% sample will result, with 50 chambers a 2% sample, etc. In many cases it is desirable that the mechanical sampler should cut from the stream of pulp a sample bearing a much smaller ratio to the entire pulp than could be obtained practically in this way with a single wheel, owing to the very great number of divisions it would be necessary to have in such a wheel. The obvious way to avoid this difficulty is to make two cuts of the sample with two independent wheels, thereby multiplying the ratios of reduction and obtaining a comparatively small sample.



PARTS OF THE SAMPLER

Since the wheels operate entirely independently of each other, none of the elements of accuracy of the sampling process are sacrificed by the second cut, and the small portion of pulp obtained is a representative sample.

The machine here illustrated has a large and a small wheel, each of which has 50 chambers. The large wheel cuts out 2% of the pulp stream and delivers this portion to the small wheel, which cuts out 2% of what it receives, so that the final sample is 0.0004 (0.8 lb. per ton) of the pulp passing through the sampler.

The two wheels are mounted on one vertical shaft, the large wheel above, and the whole apparatus is suspended in a suitable box that catches the pulp as it falls through the wheels. The pulp is led into a chamber (tightly covered to prevent splash) above the large wheel and is discharged through a set of short pipe nipples let into the bottom of the chamber at a slight angle with the vertical, so that the pulp striking the vanes of the large wheel causes it to revolve. These discharge pipes are placed approximately in a ring, the center coinciding with the axis of the wheels in order that the discharge of pulp may be symmetrical with respect to this axis.

The pulp caught by the closed cell of the large wheel is spread by a distributor over about a third of the area of the small wheel. This was found necessary, as when no distributor was used the closed chamber of the small wheel was not large enough to hold and carry off the pulp

*Chiksan Mining Co., Chiksan, Chosen.

[1] "Handbook of Milling Details," McGraw-Hill Book Co., Inc., New York.

discharged into it at the instant it passed under the delivery spout of the large wheel. With the distributor the closed chamber of the small wheel catches and carries off the same amount of pulp during one-third of a revolution that it would otherwise have to catch in perhaps one-twentieth of a revolution. This allows it to operate without overflowing.

The motion of the small wheel is effected by eight arms, or paddles, fastened at an angle to its outer rim like the arms of a windmill, of such a length as to project into the main stream of pulp as it falls through the pockets of the large wheel. The pulp, striking the slightly inclined paddles, causes the wheel to revolve. It was at first attempted to control the motion of the small wheel simply by the force of the pulp diverted to it by the large wheel. Under these conditions the small wheel worked erratically and was liable to stop, so that the paddles were added to make its motion stronger and more certain. The two wheels turn in opposite directions at about 7 r.p.m. for the larger and about 13 for the smaller, constant and uniform motion being secured by this means.

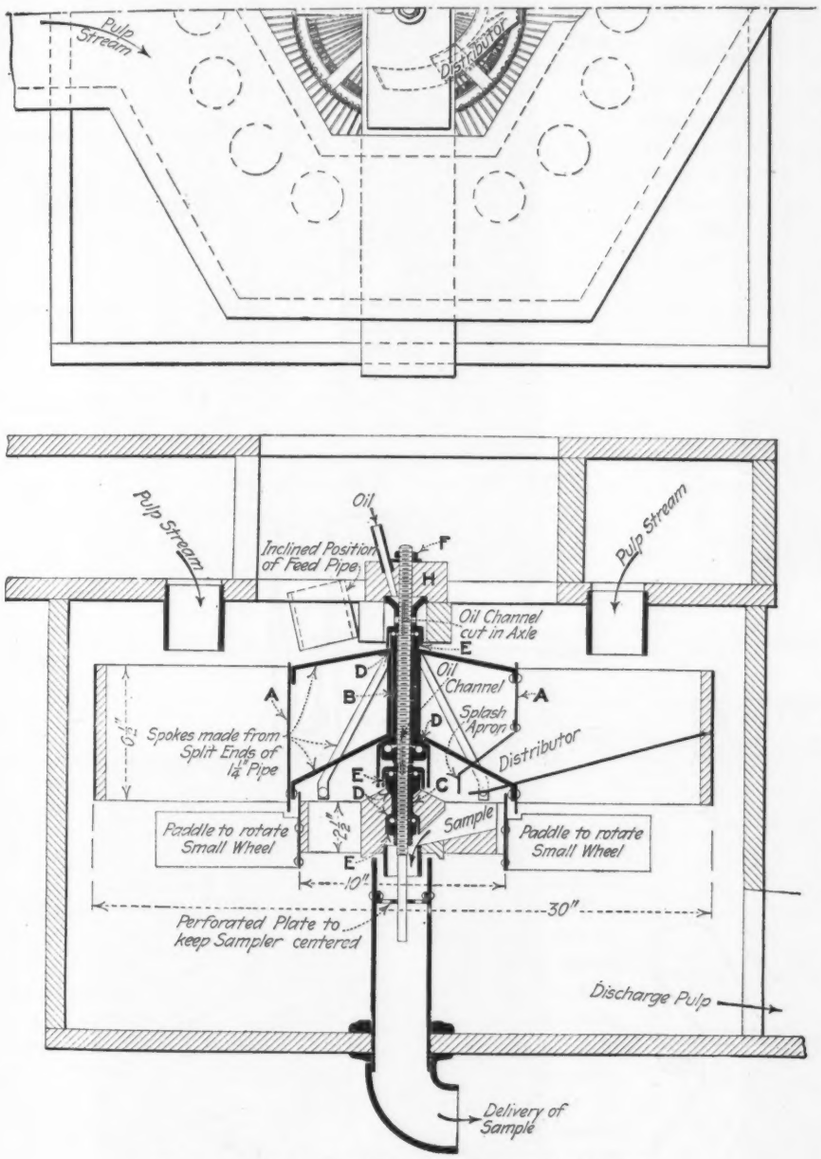


DIAGRAM OF THE AUTOMATIC PULP SAMPLER

The vanes of the large wheel are made from $\frac{1}{16}$-in. sheet iron. At their outer ends they are held between equal-sized pieces of wood driven between them inside of the outer rim, which is also of $\frac{1}{16}$-in. iron. The inner ends of these vanes are riveted to an inner band of sheet iron *A*. The hub of the large wheel was made from a piece of 1¼-in. pipe. Cut to a suitable length, each end was split longitudinally with a hacksaw into 8 segments, and these segments were then bent so as to form staggered spokes with the central complete portion of pipe as the hub. The outer ends of these spokes were then riveted to the inner band *A* in such a manner as to hold the section of pipe exactly at the center.

The small wheel is made of the same material as the large one. Its hub is a piece of oak turned in the lathe, and the inner ends of the vanes are held by being inserted in saw cuts in this hub. The outer ends are held by blocks of wood similar to those of the large wheel. All bearings were made of mild steel turned out in the lathe and smoothed up carefully, after which they were case-hardened. The hub bearings of each wheel are made in two pieces so as to screw together, as shown at *B* and *C*, and the surfaces *D*, that clamp the hubs of the wheels, are conical so that the hub bearings center themselves when screwed tightly together in the hubs. To prevent water and grit from working into the bearings, the upper one in each case comes outside of the lower one and forms an overhanging guard. Also the outer surface of the lower bearing in each case is conical, so that the annular space between it and the protecting apron is larger at the bottom than at the top, as shown at *E*. As first constructed, not enough attention was given to this feature and the bearings had to be redesigned to keep out the grit. The balls are the ordinary steel balls of ¼- and ⅜-in. size used in bicycles. After five months of constant use the bearings show no appreciable signs of wear.

All bearings are oiled from one point at the top of the axle. At each place on the axle where bearings or nuts are screwed to it, a groove or channel is cut through the threads so that the oil put into the top hole works into all the bearings. The axle that supports the machine is a steel bolt, ⅝ in. at the upper part and ½ in. at the part that supports the small wheel. Its upper end is passed through a 2x4-in. timber *H* and tightly clamped to it by means of the nut *F*. This timber rests across the containing box.

The chamber that feeds the pulp to the sampler is made so it can be lifted off of the containing box, and an emergency bypass launder is built into the box. To gain access to the moving parts of the sampler, it is only neces-

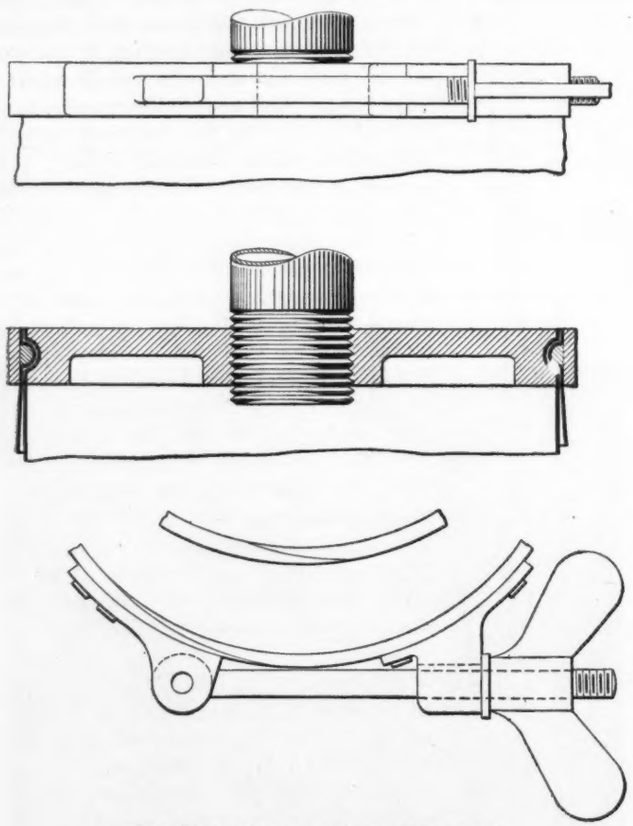
sary to divert the pulp stream into this bypass launder and remove the feed chamber. The supporting timber *H* with the wheels may then be lifted from the box.

Occasionally the sampler has been found hung up by a small stone, or the like, too large to pass through the small wheel, becoming lodged between the small wheel and the distributor and locking the wheels together. Beyond such rare occurrences, removing the sample once a day and oiling, the sampler requires no attention. It operates without splash on the tailings of a 45-stamp mill carrying about 180 tons of solids and 1,440 tons of water in 24 hours.

Holder for Precipitate Bags

A holder for precipitate bags has been invented by H. R. Conklin, the idea being to provide a convenient method for cleaning up the precipitate from cyanide plants using zinc dust as a precipitant, where a filter press is not installed. The general method of procedure has already been described in the *Journal*[1], but this improvement simplifies operation and enables the bags to be used over again.

The device is simple, consisting of a casting that receives the delivery pipe and also has a semicircular



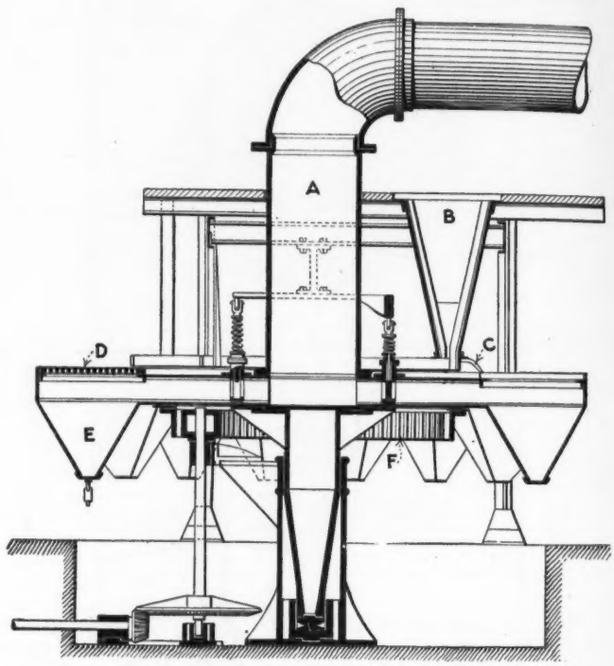
HOLDER FOR PRECIPITATE BAGS

depression in its outer edge. The bag or bags fit over this casting and are held in place by a split ring that also fits into the depression. Outside of the whole a spring clamp-ring with a screw tightener acts to fasten the members rigidly together. The apparatus is shown clearly in the accompanying drawings. The device has been granted United States patent No. 1,169,241.

[1]"Handling Precipitate at Lluvia de Oro," May 17, 1913.

Annular Sintering Apparatus

Dr. Franz Meyer, of Englewood, N. J., has patented (U. S. Pat. 1,666,142, assigned to Dwight & Lloyd Metallurgical Co., of New York) a sintering apparatus consisting of an annular receiving grate and a central upright hollow mast with suitable air connections for producing a down draft on the sintering grate. The means for feeding and igniting the charge are, in a general way, similar to that in other forms of the Dwight & Lloyd sintering machine, and a series of conduits communicating with individual sections of the grate space automatically control the supply of air to the sintering charge. The grate is caused to revolve, and the sintered charge is removed by means of steel teeth



ROTATING DWIGHT-LLOYD SINTERER

and a diverting plate set at an angle to discharge the sintered material to the outside of the machine.

Several different forms of the apparatus are illustrated in the patent specifications, only one of which is reproduced herewith.

A is the hollow mast through which the air and roast gases are exhausted, *B* is the feed hopper for the ore or other materials to be agglomerated, *C* is the plow which removes the sintered material from the grate, *D* is one of the grates, and *E* is one of the series of hoppers placed below the grates to receive any fine material that may drop through. These hoppers are closed at the bottom by a weighted door or gate, which may be opened either automatically or manually for the removal of this material as it accumulates. *F* is the gear that revolves the annular grate. In case the material to be roasted contains insufficient or no agglomerating constituents, as in the treatment of zinc ores in the manufacture of zinc oxide, guards are placed on the outside of the grate to prevent the material from being spilled over the edge. These guards may be provided for such distance as may be required, until the charge is agglomerated, or for practically the entire periphery if necessary.

Mining Men in the Public Eye

JAMES RALPH FINLAY

A distinguished mining engineer, elected president of the Mining and Metallurgical Society of America

LOUIS D. RICKETTS

"Arizona's most distinguished citizen," recently elected president of the American Institute of Mining Engineers

ARTHUR A. COLE

One of the most prominent of the Canadian mining engineers. He has just been elected president of the Canadian Mining Institute. He is mining engineer for the Ontario government railway commission, with headquarters at Cobalt.

SIDNEY J. JENNINGS

Vice-president, in charge of mining explorations of the United States Smelting, Refining and Mining Co., recently elected first vice-president of American Institute of Mining Engineers

Labor Conditions in Ontario

TORONTO CORRESPONDENCE

The increased activity among the different mines of Ontario during the past six months has been marked, and while the returns for the year show a decrease in the production of several metals and minerals, the outlook for the present year is very encouraging.

Ten years ago, when Cobalt was in its infancy and before it gave promise of such wonderful productivity, Sudbury was the only mining district of great importance. Several gold-mining excitements had collapsed, and the history of gold mining was such that the possibilities in this direction were not considered encouraging. The number of men employed in the mining industry was small, and the scale of wages and living conditions were far from being satisfactory.

Today Ontario has one of the most important gold camps on the continent, and has several others of considerable promise. Mining is one of the most important industries of this province, which leads the rest of Canada in the output of its mines and smelteries, and it seems destined to increase this already commanding lead. While Porcupine is the main gold-producing center, the newer camps of Kirkland Lake, Munroe and Boston Creek are important.

JURISDICTION OF THE DEPARTMENT OF MINES

In the different mines, quarries and metallurgical works that come under the jurisdiction of the Department of Mines, there is a total of about 15,000 men employed. The Sudbury district employs about 6,000, Cobalt 2,600 and Porcupine 2,200. It is interesting to note that four companies employ over 50% of the total mining labor of the province. These are the Canadian Copper Co. and the Mond Nickel Co., of Sudbury, and the Hollinger and Dome mines, of Porcupine. The Canadian Copper Co. is the largest individual employer, with about 3,500 men.

Employees in mines and the allied industries are now enjoying a much better position than they were a year ago. At that time, on account of the partial closing down of the plants at Copper Cliff, a large number of men were thrown out of employment, and the drop in the price of silver resulted in a similar condition in Cobalt. No new work was being started, and a number of small nonproducing properties were closed down.

These conditions have, however, entirely changed, so that at the present time good labor is at a premium and there is some possibility of a shortage. As a matter of fact, there is a shortage of good Canadian and American labor, and the demand for additional men has necessitated the employment of an unduly large proportion of inexperienced foreigners. This condition will probably exist until after the war or until the higher wages and scale of living that now prevail attract a better class of men.

There are several reasons for this shortage, among which are: The greatly increased output of the Sudbury district, where the plants are working at maximum capacity; the establishment of a universal 8-hr. day with increased wages by the Canadian Copper Co., which necessitated the employment of a large number of new men; the greater activity in Cobalt due to the rise in the price of silver; the large number of men who have enlisted for the war, and to a lesser degree to the number of alien enemies that have been interned.

As the different camps have become more settled, the living conditions have steadily improved. The scale of wages and living conditions now compare favorably with any place on the continent. In Northern Ontario, where 80% of the mining labor is employed, the following wage scale is in effect: Drill runners, $3.25 to $3.50; drill helpers, $3; muckers, $2.50 to $2.75. Other classes are paid at corresponding rates. As board costs only 60 to 75c. a day and as the eight-hour law is universal underground and at a large number of mines on the surface and in the mills and smelteries, it will be seen that wages are higher than in the majority of western camps.

The Government Mine Inspection Department is active and impartial. The operation of this department, together with the employment of safety engineers by a number of the mining companies, has resulted in a very favorable accident rate. Last year there were 58 fatal accidents, or an average of 3.6 per 1,000 men employed.

During the past year the Workmen's Compensation Act came into effect; it provides suitable compensation for death and all injuries, except in cases where the disability lasts less than seven days and except where the accident was the result of the serious and willful misconduct of the workman and does not result in death or serious disablement. The act is administered by a special commission appointed by the government.

The outlook for labor in Ontario is good. The different mining camps are within a comparatively short distance of one another, thus giving a large concentration within reasonable traveling distances. The present camps are, with the exception of Cobalt, showing a rapid expansion, and the increase in the price of metals and minerals has stimulated the development of copper, molybdenum, graphite, pyrite, lead and zinc properties. If some of these become established on a sound basis during the present period of high prices, it is altogether probable that they will be able to maintain operations even with lower prices for their products.

Peat-Phosphate Fertilizer

That a big field for large capital investments exists in the expansion of mineral industry in Idaho and Minnesota and the establishment of fertilizer-manufacturing and distributing centers in the adjacent grain states to the east, west and south is the opinion of Robert N. Bell, state inspector of mines for Idaho, who is now visiting New York. Southeastern Idaho, says Mr. Bell, contains vast resources of high-grade rock phosphate, a partial survey of the Idaho part of the western phosphate field by the government geologists having already outlined the existence of several billion tons of this valuable mineral.

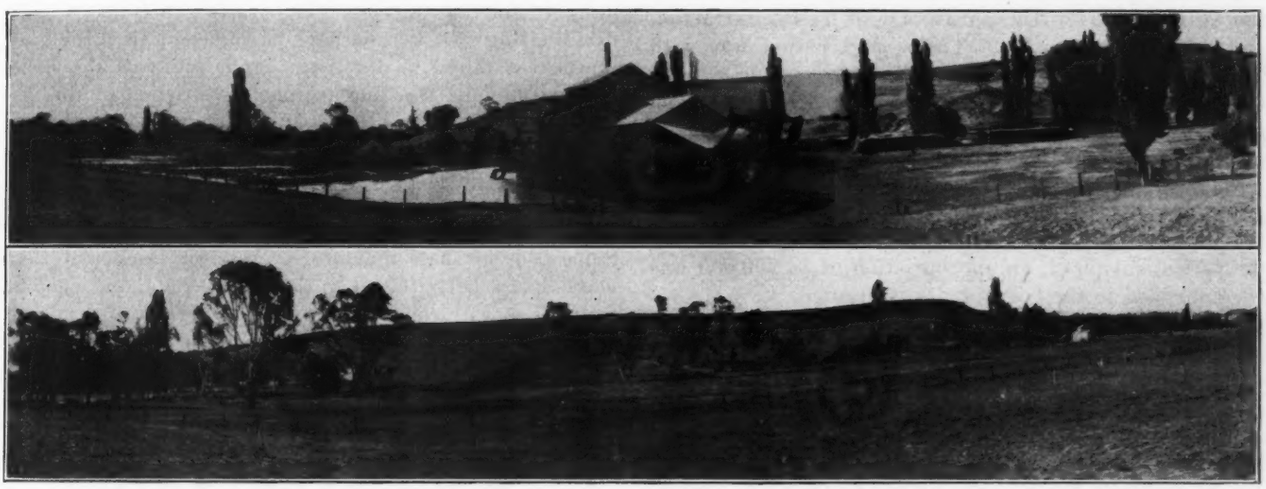
Professor Soper, a member of the present faculty of the University of Idaho and formerly connected with the geological survey of Minnesota, who has specialized on the peat resources of that state, says that the glacial basins of northern Minnesota contain tens of millions of tons of easily available high-grade peat deposits, and it is believed by these authorities that a combination of finely ground raw phosphate rock and ground sun-dried Minnesota peat would form a perfect fertilizer for run-down or exhausted soil, by renewing its organic matter and primary fertility at a relatively low cost. From numerous analytical tests Minnesota peats are shown to contain from 1½ to 2½% free nitrogen and would form an

ideal culture medium in soil combination for the further development of nitrogen-fixing bacteria, besides furnishing abundant humus to fallow the soil, free the phosphates and stimulate the release of the abundant natural soil potash—and be free from the objectionable feature of adding undesirable acid to already acid soils, which superphosphate mixtures involve.

Mr. Bell believes there is a big field for mining, manufacturing, agricultural and transportation expansion in this simple and cheap combination of rich fertilizing elements in the Upper Mississippi Valley states, in which his state can supply the most vital element, and in connection with Professor Soper intends shortly to submit a joint paper on the subject for discussion.

Resoiling in Australia

The Sludge Abatement Board, of Victoria, Australia, has been active in working for the reclaiming of dredged lands and through its efforts the territory that has been dredged over is no longer a barren and useless waste. An illustration of the results secured is given in the board's report published in 1915. A description is given of the work of the Guildford bucket dredge, operating on Loddon River, 8 mi. below Castlemaine. The accompanying illustrations show the dredge working downstream in Stephens' flat. The upper picture shows the dredge and the dredged ground in the stern of the plant, the area to be dredged showing in the foreground. At the left is about 4 acres of land that has been dredged and resoiled.



THE GUILDFORD DREDGE IN THE LODDON RIVER, SHOWING THE PLANT AT WORK, AND, IN THE LOWER VIEW, THE RESOILED AREA

The company is working land with 4 or 5 ft. of sandy silt on top, under which there is about 16 ft. of black loam and clay over the washes. The loam and silt are stripped in advance and placed on top of the dredged tailings, forming a uniform and useful surface. The lower illustration shows an area that has been dredged and resoiled, in Stephens' flat. The dredge makes use of a loam chute and silt distributors, but the mixture, after being deposited on the dredged land, is leveled by hand.

Owing to shortness of water during the 1914 season, the dredge had to conserve its supply, and full-scale work could not be carried out. In 1914 the company treated 593,000 cu.yd., recovering 2,233 oz. of gold from 12¼ acres, and declared £3,325 dividends on £7,000 capital.

Earthquake Danger Not Great at Panama Canal

The slides in the Culebra Cut of the Panama Canal have made necessary the removal of about 30,000,000 cu.yd. more earth and rock than was originally estimated. Donald F. McDonald, who was geologist to the canal commission, and is now with the United States Bureau of Mines, in a recent bulletin[1] reviews the geologic conditions and concludes that no permanently insuperable obstacles to the operation of the canal are presented by the slides or by future earthquakes. As to the stability of the Panama region, Mr. McDonald states that there is a record of four oscillations, and the beginning of another elevation. Should the rise be rapid, the canal would of course be in some danger, but the average rate of uplift for the last 1,000 years has been less than 0.03 ft. per year, or less than 3 ft. in 100 years. The various oscillations of the land above and below sea level have resulted in the fracture and faulting of the softer rocks and have provided ideal conditions for the sliding of the soft mud-like material. Reverting to the earthquake danger, Mr. McDonald summarizes as follows his reasons for believing that the canal is not likely to be destroyed in this manner:

1. The large number of tremors detected every month by the recording instruments is evidence that slow adjustments are constantly taking place and thus that no great accumulations of stress that might later culminate in a big shock are probable.

2. The absence from the Isthmus region of high mountains and of geologically recent volcanic activity is evidence in favor of the probable absence of earthquakes, especially as such high mountains are a striking geologic feature of the whole Central American earthquake belt.

3. The presence of numerous small faults and of the faulted conditions of such volcanic cores as Gold Hill and Contractors Hill is evidence that adjustment here has progressed well on toward normal conditions of equilibrium.

4. The tensile strength of the majority of the rocks within the Canal Zone is rather low, and they would shear with comparative ease, thus preventing any relatively great accumulation of stress that might result in a comparatively intense shock. However, experience teaches that where earthquakes happen the buildings suffering the maximum destructive effects are those built on loose and friable material. This consideration might therefore subtract a little from the saving benefits of the yielding and preventive qualities of the Canal Zone rocks.

[1]Bull. 86, United States Bureau of Mines, Washington, D. C.

5. Over 300 years of earthquake observation shows only two shocks of considerable magnitude, and there is every reason to believe that the more severe of these would not have seriously damaged even the most delicate parts of the canal.

That many small and harmless shocks will traverse the Canal Zone is certain, but that the canal is in any real danger from earthquakes is contrary to all the evidence.

New Cornelia Copper Co.

According to the report of the Calumet & Arizona Mining Co. for 1915, the process work at the New Cornelia Copper Co., at Ajo, Ariz., was continued throughout the year, a 40-ton experimental plant having been in operation since Feb. 1 of that year.

To Dec. 31 there were 291 charges leached—approximately 12,222 tons. The work may be divided into two distinct periods, the first including the work done up to charge 81. It was then decided to begin again with new solution. Charges 82 to 90 inclusive were discarded. The second period began with charge 91 and continued thoughout the year.

For the first period the heads averaged 1.248% and the tailings 0.294% Cu, an average of 74.4% extraction and 0.72 lb. per kw.-hr. The second period was with heads averaging 1.337% and tailings averaging 0.256% Cu, an extraction of 80.6% and an average of 0.958 lb. per kw.-hr. The 1-ton plant was operated from Aug. 8, 1914, to Nov. 3, 1915, with average heads of 1.325% and tailings of 0.283% Cu. The average extraction was 79%, and 1.125 lb. was produced per kw.-hr. In the belief that these results justified the immediate construction of the permanent plant, an appropriation of $4,200,000 was recommended to the board and was granted.

The new plant, when completed, will put the property on a production basis of 36,000,000 lb. of copper per year. The mine will be opened up so that three 100-ton steam shovels will load ore into cars, these being hauled about a mile to the mill. The cars will be electrically dumped into large gyratory crushers, of which there will be one No. 24 and four No. 8, crushing the ore down to 3½ in. The fine-crushing plant will have 12 Symons disk crushers, reducing the ore to ¼-in. size.

The leaching plant, which will receive the ore from the fine-crushing plant, will have 11 lead-lined tanks, each 88 ft. square and 15 ft. deep, holding 5,000 tons of ore. In addition there will be one sludge tank of the same dimensions. Each tank will have pumping equipment for circulating and advancing solution at the rate of about 8,000 gal. per min. Tailings will be removed and loaded into cars by an excavator of the Hulett type.

Neutral solution from the leaching plant will be pumped to four sulphur-dioxide towers, 20 ft. diameter and 40 ft. high, for the reduction of ferric iron to suit the requirements of the electrolytic plant. From the absorption towers the solution will go to the electrolytic plant, circulating through the cells, the acid solution returning to the leaching plant. The tankhouse will contain 152 lead-lined tanks 30 ft. long, 4 ft. wide and 5 ft. deep.

The power plant will contain five 822.6-hp. boilers and two 7,500-kw. steam turbines. Other equipment, such as shops, warehouses, storage tanks, and water supply, will be provided as required. It is estimated that the plant will be completed about July 1, 1917.

Gasoline from Shale

In view of the ever-increasing demand for gasoline and the increase in price of crude oil, from which it is obtained, it is important to know that an almost inexhaustible supply of oil may be obtained from the shale of northwestern Colorado, northeastern Utah, and southwestern Wyoming, according to the U. S. Geological Survey. This shale contains materials which, when heated, may be converted into crude oil, gas and ammonia. The high cost of distilling oil from shale as compared to the cost of producing oil from wells has thus far prevented the development in this country of such an industry and may continue to prevent it for some time, but sooner or later this great source of supply will be utilized to supplement the decreasing production from the regular oil fields.

The oil derived from the shale is similar to that which is being produced from wells. When refined by ordinary methods, the shale oil yields an average of about 10% gasoline, 35% kerosene and a large amount of paraffin. The yield of gasoline from the shale may probably be largely increased by the use of refining methods especially designed for that purpose. The gas, which is a very good illuminating gas, will perhaps be sufficient to furnish all the heat required to distill the crude oil from the shale.

The ammonia is a most valuable byproduct of the distillation and may be utilized in the manufacture of commercial fertilizer or other nitrogen compounds, as the market demands. The United States Geological Survey has examined large areas of the shale in Colorado, Utah and Wyoming and has made many distillation tests. Some beds of shale that are several feet thick will yield more than a barrel of oil to the ton of shale, and one bed 6 in. thick will yield more than two barrels of crude oil to the ton of shale. One ton of this shale should therefore yield nearly 10 gal. of gasoline by the present commercial methods of gasoline extraction, and larger yields may be made possible by new methods.

Yukon-Alaska Trust

The Guggenheim Exploration Co., capitalized at $22,000,000, has been dissolved as a New Jersey concern. The shareholders at a special meeting voted to ratify the creation of the Yukon-Alaska Trust to take over the assets of the Exploration company after the distribution of stock and $12 per share cash. The assets held by the Trust comprise $1,000,000 cash, about 2,800,000 shares of Yukon Gold, 500 series "A" preferred stock of the American Smelters Securities Co., obligations of Yukon Gold. Co. and other property. One of the unnamed assets turned over to the Trust is an important interest in the Belgian Congo Co.

The Electrolytic Refining and Smelting Co., at Port Kembla, Australia, has started excavating for the building of additional works, to be erected at a cost of about £100,000. Last year the works produced about 24,000 tons of refined copper, the chief supplies coming from Mount Morgan, Mount Lyell, Hampden, and Cloncurry mines. The capacity of the present smeltery, which treats copper, gold and silver ores, is 36,000 tons per annum. Since the outbreak of war and the consequent suspension of German competition, blister copper and matte have been received from different parts of Australia for treatment. The additional works are in response to an appeal of the Commonwealth Government to have all such ores treated entirely in Australia, and also the copper and products as well.

Editorials

At Last!

The raid of Villa and his bandits into New Mexico was the straw that broke the back of a very patient camel. Washington then promptly ordered military action, and up to the present time seems to be minded to do everything that is necessary, no matter if Carranza opposes, no matter if it spells intervention.

At last! To the men of the mining industry, to our readers, no comment beyond those two words is necessary. With the institution of decisive action the eradication of the sore will not be long delayed.

Progress of "Dollar Exchange" in South America

"Dollar exchange" is becoming a reality in "mining South America," especially on the West Coast, where the American Smelting and Refining Co. has important mining interests and has lately made dollar exchange in Chile a *fait accompli*. Prior to the war, practically all mining companies in South America had to finance their needs with 90-day sight drafts in pounds sterling drawn on London. When the war began London credits were cut and the situation become difficult for mining companies requiring local currency. The Braden Copper Co. and the Chile Exploration Co. began to sell 90-day sight drafts on New York in pounds sterling in order to procure Chilean currency to meet their payrolls. This expedient, however, was impractical as a permanent usage. To eliminate this circuitous method, Leopold Fredrick, director of the American Smelting and Refining Co. and treasurer of the Braden and Chile copper companies, went to Chile and took active steps for the introduction of dollar exchange. He secured the coöperation of the Chilean authorities, and an official quotation for dollar drafts was established in Valparaiso.

Through the success of Mr. Fredrick's campaign, the Chilean business of these three companies, amounting to several millions per month, is now being financed by 90-day sight bills drawn in dollars on New York. No other form of exchange has been used in Chile by these companies since the beginning of 1916. This innovation will save the companies an important amount of money formerly paid to London in the form of banking commission and interest. While in Chile, Mr. Fredrick also presented to the government a suggestion that the payment of export duties on nitrate shipped to the United States be made partly in gold and partly in 90-day sight bills drawn in United States dollars. A bill to this effect is now being drawn up by the Chilean government. At present these duties are paid partly in gold and partly in 90-day sight bills on London.

Dollar exchange will probably be established in Bolivia at an early date and is also in prospect in Peru, in both of which countries 90-day sight drafts on New York have been frequently used since the outbreak of the war. In Ecuador dollar drafts on New York have been used for a number of years by the principal mining interests, and other industries have been drifting to this practice since trade with Central Europe was cut off. On the East Coast dollar exchange has been fairly well established for several years, but the mineral deposits of the East Coast republics are as a rule far from the sea—like our own Western deposits—and these countries have not yet taken the important position in the mining world that they will some day assume. Hence the establishing of dollar exchange on the West Coast of South America is a matter of immediate importance to mining operators who may contemplate entering this field for the next stage of its mining development—the operation of the great low-grade deposits and of richer ones made commercial by better transport facilities.

Lead and Spelter Conditions

A reading of the commercial daily newspapers of New York gives us an explanation of the recent decline in spelter and the curious behavior of the American Smelting and Refining Co. in the lead market. In both cases it is manipulation pure and simple. Spelter has been depressed in order to enable the smelters to obtain cheap ore. As soon as they have secured enough, there will be a sharp upturn in the spelter market. Similarly the American Smelting and Refining Co. has been selling lead at 6.60c., while others have been getting 7@7½c., simply in order to hold down the market while securing ore. It is anticipated that the smelting company will soon announce some strong advances, inasmuch as the ore purchases have been completed.

These explanations are soul-satisfying until one pauses for reflection. The bulk of the zinc ore is taken in on sliding-scale contracts, and a low price does not increase the offering. Moreover, many of the newer contracts recognize no price for spelter in excess of an arbitrary maximum, say in the neighborhood of 10c. Also, there are still producers of zinc ore who are troubled by inability to sell their ore at all and welcome any chance to do so.

Lead ore is bought on sliding-scale contracts to an even greater extent than zinc ore, and depression of price does not stimulate the inflow. Moreover, the larger part of the lead goes into consumption on the same quotations that it is taken in. The arbitrary differentials between New York and other points operate in favor of the smelting companies, but this does not contravene the general principle of equality of intake and outgo.

In the case of spelter the tiresome old law of supply and demand seems to be the more adequate explanation of the recent behavior of the market. With respect to lead the desire to protect regular customers against the machinations of speculators may have played a part. At all events important producers other than the American Smelting and Refining Co. have been willing to sell lead to their regular trade for less money than they have been bid by outsiders.

Later—The American Smelting and Refining Co. having apparently accomplished its purposes, raised its price to 7c. on Mar. 14. On the same day the report came from Joplin, Mo., that the zinc ore producers there are planning to restrict sales in order to force smelters to pay higher prices.

Military and Mining Engineering

The series of lectures on military engineering being given by United States Army engineers, the program of which was noted on page 306 of the *Journal* for Feb. 12, is attracting the greatest interest among the members of the great national engineering societies. Four lectures have thus far been given. The responses to the first notices sent out were so numerous that an overflow meeting was provided for those who could not be accommodated in the main auditorium, which, by the way, holds about 1,500. This overflow meeting proved to be entirely inadequate, and several hundred were turned away on the night of the first lecture. As a result, a second overflow meeting was provided for the second lecture which was held at 5:30 in the afternoon, and the regular evening overflow meeting had to be transferred to the quarters of the American Society of Civil Engineers in order to get a larger hall. The large number of strictly technical men attending these lectures is most significant of the appreciation of both the need of national preparedness and the duties and obligations of the engineer thereto.

The first lecture dealt with the general duties of engineer troops in warfare, with especial reference to bridge-building requirements, both ponton and trestle. The second dealt with the service of reconnaissance, including surveying, mapping, sketching, photography and map reproduction in the field. While all of the work covered by these two lectures could well be done by mining engineers, it perhaps falls more specifically within the sphere of civil engineers. The third lecture, however, delivered Feb. 28, on "Field Fortifications, Sieges and Demolitions," covers work that falls distinctly within the scope of the mining engineer and is, in fact, that branch of the service to which mining engineers will be assigned in time of war. The lecture is reproduced almost in full elsewhere in this issue and is an exposition of modern trench warfare, with all the little arts thereto pertaining.

It is rare that a technical exposition of this subject is made so readable, and still more rare that it is made available to civilians; therefore under the circumstances and the exigencies of the times this is a welcome contribution to the literature of military engineering.

The galleries of the military engineer are the drifts of the mining engineer and are driven from the intrenchments of one belligerent to undermine the trenches of the other. The details of this work are illustrated in the "Engineer Field Manual."[1] Some of these, reproduced in the lecture mentioned, show methods of timber support for the roof and sides of these drifts, methods of spiling in soft and loose ground, method of shaft sinking, shaft lining and cribbing, identical with the everyday work of the miner, prospector and mining engineer.

It is for this reason that the miners of Canada and of Cornwall have been especially recruited for this arm of the service in the present war, and it is upon our own mining industry that this country will depend for similar service in the time of our extremity. The national engineering societies are coöperating with Major General Leonard Wood and his staff in affording the engineering profession every opportunity possible to acquire such information as is possible from illustrated lectures which shall be a foundation for more intensive study and work along these lines later on. Owing to the exigencies of the Mexican-border situation the Plattsburg and other summer training camps have been canceled.

[1]"Engineer Field Manual," Professional Paper 29, Corps of Engineers, U. S. A., procurable from Superintendent of Public Documents, Washington, D. C., at $1 postpaid.

Education of Mining Men

Periodically recurring is the question of the education of those who propose to go into the mining business. Recently the remarkable falling off of registration in mining schools has brought the subject again to the fore—principally noticed by educators, who are naturally the first to perceive such changes. They are now asking what is the trouble and what ails the mining industry that so many of those educated to go into it leave it for other fields. Professor Gwillim brought up the subject at the recent meeting of the Canadian Mining Institute, pointing out that the physical conditions under which mining is carried on are usually uncomfortable and the rewards not commensurate with the denials and crudity of the life. The professor pleads for an effort to make the life "more lovely." The adverb will require some alteration to fit it into mining-camp conditions. With due respect to the opinions of those who thus academically approach the subject, we submit that these gentlemen are attempting to treat a symptom instead of the seat of trouble—a result, without reference to its cause.

Mining men may be divided into two classes: First, those who follow mining because they love it—because pioneer conditions appeal to them. This class needs no assistance. Virtue is its own reward—let it alone. The other class, by far the largest and the one whence come the complaints, consists of those who may have a technical liking for the work, but who insist upon a satisfactory financial return from it. And a satisfactory return is not the indefinite continuation of a shift-boss' pittance. Unfortunately most of the men are equipped for only that. The proof is that while shoals of technically educated young men are leaving the mining field, individuals are being brought from other lines of endeavor to direct the distinies of mining companies. Not that the engineers lack technical ability, but because they possess a great store of it to the exclusion of other qualities more necessary to the proper execution of the greater duties. What mines are managed by engineers? Few indeed, and a little search will show that those few have acquired a broad, liberal education and possess commercial instincts. There is the crux—commerce! Mining is a business; business is a profession. Combine business with technique and the world is yours. But business does not require technique; it can hire that quality. Technique does require business to succeed. There the business man leads, whether he has or has not technique. One swallow does not make a summer, nor yet a square meal. Several must be combined to lead to satisfaction. No, Professor Gwillim, your technical equipment is not at fault, nor do you require loveliness. Teach your young men to deserve and demand the recompense. Teach them good business, and future generations will arise to call you blessed.

BY THE WAY

An auction sale in New York recently produced the following job lot: $500 Stonybrook Real Estate Improvement Co. 5-year 5% bond, due Oct. 1, 1914; $6 North American Life Insurance Co. certificate; 200 shares Santa Juliana Mining Co.; 143 shares Parleys Park Silver Mining Co.; 100 shares New York & Calaveras County Gold Mining Co., and 12 shares Fishkill Boot and Shoe Co.—$16 lot. It is rather difficult to evaluate the mining stocks in a lot like this, but we have our statistician working on an estimate based on the square inch of certificate; that is, wall-paper basis.

A letter from one of the British engineers now serving with the forces in the Sudan shows how the old spirit survives the new occupation. "My present job is putting some trenches in a state of repair. The unlimited amount of sand astonishes me; it would be excellent leaching stuff. It would mostly pass a 40 mesh and stay on a 100." Picture the former enthusiastic cyanider yearning in his rest moments for a leaching plant of sufficient capacity for the treatment of the Great Sahara! It reminds us of the humorous paper of the late Doctor Lewkovitch, in which he proposed to catch lions in the African desert by passing everything through a sieve. "The lions would remain on the meshes, and there you are!"

Efficiency has various exponents; some are highly efficient and others only near-efficient. In one of the New York banking houses on Dec. 31 there was a question among the bookkeepers, according to the *Wall Street Journal,* as to which of two salesmen was entitled to a commission of $1.08. It was put up to the cashier, and he said, "Give it to both of them and charge the extra expense to profit and loss." One of the members of the firm came around and wanted to know the difficulty. This was explained, and he said the mistake must be found and that only the man entitled to the $1.08 should receive it. At five minutes past eleven New Year's eve the wandering $1.08 was located, after going through all the vouchers for the year, and the firm had spent $24 in supper money. Then the member of the firm went home with the shouts of the bookkeepers wishing him "A Happy New Year" ringing in his ears.

As reported by the New York *Sun,* a Stock Exchange man, wondering over the contrast between the market for copper shares and that for the metal, had the inspiration to inquire from a friend, a manufacturer of brass goods, "How is your business?" "Rotten!" was the reply. "Is this quotation of 25½ to 26c. for copper a fictitious one, then?" he continued. "Anything but that," replied the manufacturer. "That's the whole trouble. When I go to get my raw material I am put on a list to await my turn. At the end of 60 days or three months a limited amount is delivered to me as a special favor. Brass is worth 35c. a pound now, as compared with 12c. a year ago. Moreover, there is every prospect that it will go higher. You can imagine what a time I have with my customers. After looking over my goods the buyers ask for quotations, and when I give them prices that just pay me for the increased cost of raw materials they jump up in the air. In spite of anything I can say, they think I am trying to make huge profits at their expense."

Canadian legislators are getting excited over a new process of refining nickel, by a metallurgist "intimately associated with the mining industries of Colorado and other Western States for many years, also Central America." The name is not familiar, but no matter; listen to the metallurgical prophecies of one of the honorable members of the House of Commons at Ottawa, who expresses his belief regarding the "new metallurgy" as follows: "I cannot pass judgment on certain information that has come before me in the last few months . . . but I believe that a process of refining not only nickel, but every other metal, has been developed in this country . . . Instead of the International Nickel Co. taking 100 lb. of their ore and roasting it into matte which produces less than 5 lb. of nickel, by this new method they will be able to get 70 lb. of alloy in a powder. . . . That powder is then put in a crucible and gives 50 lb. of metal—the equivalent of 50 lb. of nickel in making nickel steel. There is the revolution. It has been effected in our own country, and I believe it is a fact that out of 100 lb. of our nickel ore [It contains about 2% Ni—Editor.] we shall get 50 lb. of nickel, which is the equivalent pound for pound of the nickel that is used in making nickel steel." These legislators probably understand each other thoroughly and so do not take too seriously the "metallurgical lectures" that are now being so freely offered in the Canadian Parliament.

The poet of the Nevada Consolidated Copper Co. has written the following verses in honor of an official attached to the staffs of the big mining and smelting companies, who receives but slight attention in the engineering papers, but whose services are highly valued nevertheless.

THE PLANT PHYSICIAN

Formerly Doc wore a smile that was affable,
O'erspreading his mug very smug night and day,
Tho' twenty-four hours on the job wasn't laughable—
With naught but a "Thank You" for overtime pay.
Seldom inclined to be captious or quizzical
With those who were ailing or thought they were ill,
He doctored their ailments, mental or physical,
By culture of will power, plus powders and pill.

Lately the Doc wears a scowl that is terrible,
His brow corrugated with creases of care—
Unwittingly scaring the easily scareable,
With no real intention of throwing a scare.
Microbes and germs cause his wrinkles of worriment—
Infections that follow slight scratches and cuts,
When man, disregarding aseptic experiment,
Continue to wallow in quack-salving ruts.

Tobacco au Cud as a plaster to minister
To fresh lacerations, despite the Doc's "Don't."
Or rancid fat pork, poultice equally sinister,
May relieve inflamed minds—and maybe they won't.
Home-remedy (?) stunts and nostrums injurious,
When doped on in ignorant brain-blighted stealth,
Worry the Doc and he raves something furious
At men who thus fracture the laws of good health.

Fixing "bad-orders" with him is no rarity;
He never "wrecks" men who will stand for repair;
But nursing a grouch with a heart full of charity
Is really hard work when one wants to be square.
If only the boys with their injuries trivial
Would call on the Doc for inspection and care,
Maybe in time he'd again be convivial,
Radiate sunshine and forget how to swear.

NEW PUBLICATIONS

INDUSTRIAL USES OF FUEL OIL. By F. B. Dunn. 5x8½, pp. 235, illus.; $3. Technical Publishing Co., San Francisco, Calif.

THE MINERAL PRODUCTION OF PENNSYLVANIA FOR THE YEAR 1913. Pp. 108, Report No. 11. Richard R. Hice, State Geologist, Beaver, Penn.

HEATON'S ANNUAL. The Commercial Handbook of Canada and Boards of Trade Register. 4¾x7¼, pp. 506; $1.25. Heaton's Agency, Toronto, Ont., Canada.

ENGINEERING AS A CAREER. A Series of Papers by Eminent Engineers. By F. H. Newell and C. E. Drayer. 4¾x7½, pp. 214; $1. D. Van Nostrand Co., New York.

GEOLOGY AND UNDERGROUND WATERS OF THE NORTHERN LLANO ESTACADO. By Charles Laurence Baker. Pp. 225, illus. Bulletin No. 57, The University of Texas, Austin.

THE JOURNAL OF THE IRON AND STEEL INSTITUTE, Vol. XCII, No. II. Edited by George C. Lloyd, Secretary. Pp. 384, illus. Iron and Steel Institute, London, S. W., England.

THIRTEENTH BIENNIAL REPORT OF THE BUREAU OF MINES OF THE STATE OF COLORADO FOR 1913 and 1914. 6x9, pp. 228, illus. T. R. Henahen, Commissioner of Mines, Denver, Colo.

WATER POWER ENGINEERING. The Theory, Investigation and Development of Water Powers. By Daniel W. Mead. 5¾x9, pp. 843, illus. Second Edition, $5. McGraw-Hill Book Co., Inc., New York.

CHEMICAL PATENTS. By Seabury C. Mastick. Reprinted from the "Journal of Industrial and Engineering Chemistry," Vol. VII, 1915. 6x9, pp. 88, paper. Mastick & Lucke, 2 Rector St., New York.

TEST METHODS FOR STEAM POWER PLANTS. A Reference Book for the Use of Power Station Engineers, Superintendents and Chemists. By Edward H. Tenney. 4¾x7¼, pp. 224, illus., leather; $2.50. D. Van Nostrand Co., New York.

PRINCIPLES OF DEPRECIATION. By Earl A. Saliers. 5½x8½, pp. 200, illus.; $2.50. The Ronald Press Co., 20 Vesey St., New York.

This is an excellent treatise on a subject of finance that is not commonly well understood. It contains references to the depreciation of mines and metallurgical works. The book is one that may be confidently recommended not only to accountants, but also to the administrators of business affairs.

IRON ORES: THEIR OCCURRENCE, VALUATION AND CONTROL. By Edwin E. Eckel. 6¼x9½, pp. 430, illus.; $4. McGraw-Hill Book Co., Inc., New York.

This book, by a well-known and recognized authority, is a discussion of iron ores not only in their geologic and technical relations, but also in their more general relations to industrial conditions. It is obvious that such a subject to be treated in such a way must be approached with a broad view. Mr. Eckel has been highly successful in this. His book is unquestionably an excellent and valuable piece of work.

THE CLEANING OF BLAST-FURNACE GASES. By Frederick H. Wagner. 6¼x9¼, pp. 168, illus.; $2. McGraw-Hill Book Co., Inc., New York.

This is a useful and interesting book, but it is far from being a comprehensive treatment of its subject, and in some cases the judgment of its author is questionable. The Cottrell process receives but scant attention, although in nonferrous metallurgy at least it is regarded as the coming process. The discussion of baghouses is quite unsatisfactory. The author does not hold a high opinion of this method of treating furnace gases and conveys the idea that he regards wet washers as superior. The experience of lead and copper metallurgists has been just the contrary. However, the book contains a lot of data and descriptions that will be useful to metallurgists, and it may therefore be recommended in spite of its deficiencies.

THE MECHANICAL ENGINEER'S POCKETBOOK. By William Kent. 4x6½, pp. 1526; leather, $5. 9th edition. John Wiley & Sons, Inc., New York.

No new edition of this book has previously appeared for five years, during which time notable advances in many branches of engineering have rendered obsolete a part of the former work. In addition, many engineering standards have changed during this period, all of which necessitated a thorough revision of many sections of the book. These necessary revisions have involved changes in over 400 pages of the eighth edition and the addition of more than 150 pages of new matter. Condensation of some of the old matter, extensive revisions in subjects of standard practice, the addition of machine-shop practice, the entirely new chapters on electrical engineering and many new tables give a brief outline of the change in the ninth edition. The index to the new volume is more than twice as long as the index to the old, which latter was probably the greatest point of criticism of former editions. Kent's handbook has always been a necessity to the engineer, and the excellent present edition makes that necessity all the greater.

DETAILS OF PRACTICAL MINING. Compiled from the "Engineering and Mining Journal," by the Editorial Staff. 6x9, pp. 544, illus.; $5. McGraw-Hill Book Co., Inc., New York.

Everyone who has read the two predecessors of this book, the "Handbooks" of Mining and of Milling Details, will know what to expect of it. As I said in reviewing one of them, it is like a series of conversations with companionable experts just returned from their travels and ready to describe the new and interesting things they have encountered in the line of their profession. The said travels have been among "works," under which term are included both plants in practice and the records of technical literature. What has been seen and what has been heard at second-hand are equally interesting to the stay-at-home who desires to be kept in touch with his technical world. We hear a good deal in other departments about the benefit to be gained by eliminating the middleman and bringing the producer and consumer into immediate contact. Even in commercial matters this benefit is often doubtful. There are middlemen whose services in the way of selection, advice and preparation are worth all they cost. To eliminate them would be something like removing the cook and bringing the consumer into immediate contact with the raw meat. Technical literature presents a similar situation. The middleman who collects, selects, revises and formulates the technical news is invaluable to the immature beginner and the over-busy veteran alike; and when we see books of this class, we have no doubt at all that they are just what we want if they are well done, while mere scrapbooks, compiled without critical discrimination and edited without competent care, would merely cumber our shelves.

This particular middleman's book is thoroughly well done. In the preface Mr. Ingalls gives the credit for this result chiefly to Lee O. Kellogg, recently a member of the editorial staff of the "Engineering and Mining Journal" and himself the author of many of the articles here collected.

The material of the book is taken from the columns of the "Journal" between July 1, 1912, and July 1, 1915. It thus forms a continuation of the "Handbook of Mining Details," published in 1912 and including extracts down to July 1 of that year. This time, as before, the authors are the contributors and members of the editorial staff of the "Journal"—good observers and good describers; and the reproduction of the original illustrations (440 in all) completes the clearness and usefulness of their statements.

In successive chapters the descriptions given are classified under the headings of Surface Plant and Operations, Explosives, Rock Drills, Shafts and Raises, Drifting, Stoping, Timber Structures, Hoisting, Lowering, Transporting, Shaft-Conveyances, Cars, Track, Safety and Sanitation, Drainage and Ventilation.

A glance through the hundreds of descriptions of methods and machines under these titles suggests some thoughts as to the new era, and therefore the new art, of mining. Back of all other motives for these improvements lie evidently the requirements of operations on a large scale, such as the mining in immense quantities of low-grade ore. This large scale involves increased dimensions, speed and strength, the use of new tools and materials, and provision for large numbers of workmen; and these new conditions are reflected in almost every chapter of this book—especially, perhaps, in the chapters on the surface plant, shafts, timbering, transportation, and safety and sanitation. A generation ago mining engineers rarely had to deal with the problems now everywhere presented in the making of vast excavations, the handling of vast quantities of low-grade ore and worthless waste, and the health, comfort and efficiency of vast numbers of workmen. The use of electric light and power underground has paralleled in its rapid extension the same thing on the surface, and equally important has been the progressive employment of concrete as a subterraneous building material. In short, well-nigh all the improvements in civil or mechanical engineering have been eagerly adopted by the mining engineer in his encounter with the great stresses, masses, speeds and perils, and consequently the great demands, presented by modern mining. To read these pages, therefore, is like reading the history of progress in the transformation of that ancient art. Yet some problems remain unchanged through the ages, and these vigilant authors have not been ashamed to take note of them. One studies with a smile the description of an apparatus to facilitate the shoeing of a "mean mule," which would not have been out of place on a papyrus of the age of Rameses. That is a sempiternal joke—and yet no joke!

Besides all the direct professional value of this book, I wish to give thanks for a quality more directly appreciated by a retired veteran, who does not expect hereafter to run a drill, or sink a shaft, or even shoe a mule—namely, it is intensely interesting.

R. W. RAYMOND.

PERSONALS

Kirby Thomas has returned to New York from professional work in the South.

J. P. Beck has been appointed manager of the Portland Cement Association with offices in the Conway Building, Chicago.

E. P. Worden, formerly of Fred M. Prescott Steam Pump Works, Milwaukee, has been appointed chief engineer of Henry R. Worthington, Harrison, N. J.

J. C. Gilbert, of San Pedro, Calif., has taken charge of the Anita copper mine, near Williams, Ariz., and is making preparations to begin active work.

Charles W. Newton, general superintendent of the Consolidated Interstate-Callahan Mining Co., Wallace, Idaho, has been visiting Butte, Mont., on business.

Quincy Bent has been appointed general manager of the Steelton and Lebanon plants of the Pennsylvania Steel Co., in place of J. V. W. Reynders, resigned.

H. A. Guess, formerly consulting engineer, has been appointed managing director of mining department of American Smelting and Refining Co., New York.

W. Walley Davis, formerly superintendent for the Pennsylvania district, Semet-Solvay Co., has been made manager of the By-Products Coke Corporation, of Chicago.

George Kingdon Parsons has opened an office as consulting engineer in the Equitable Building, 120 Broadway, New York. He will also retain his office in the Riggs Building, Washington.

Eli T. Conner has removed his principal office from Philadelphia to the Mutual Life Building, 26 Liberty St., New York. He will also open an office in the Union National Bank Building, Scranton, Pennsylvania.

S. A. Wookey, recently of the Hollinger mine staff, Porcupine, Ont., has been appointed manager of the Schumacher mine in place of Joseph Houston, who resigned to become assistant manager of the Dome mines.

A. A. McKay has been appointed superintendent of the Onahman Iron Co., opening the Ferro mine on the Cuyuna Range, Minnesota. He was formerly with the Canadian-Cuyuna Ore Co. at Wilcox mine, Cuyuna Range.

R. W. Clark, of the New York office of Rogers, Brown & Co., recently presented the moving-picture lecture of his company, "From Mine to Molder," before the New York School of Mines, Columbia University, New York City.

Charles W. Boise, managing engineer for the Société Internationale Forestière et Minière du Congo, is in the United States on an extended leave. He will be in New York for a week now and again before returning to Africa in August.

P. P. Bourne, formerly chief engineer of Blake & Knowles Steam Pump Works, East Cambridge, Mass., is again associated with the International Steam Pump Co. in connection with special engineering work. He is at the company's main office, 115 Broadway, New York.

D. H. McDougall has been appointed general manager of the Dominion Steel Corporation, Sydney, N. S. He is a native of Nova Scotia and was attached to the engineering staff of the Dominion Iron and Steel Co. in its construction period. He has recently been superintendent of the company's iron mines.

Charles J. Murphy, who for the past five or six years has been chief engineer of the Crow's Nest Pass Coal Co., has decided to enter private practice, and has opened an office as a consulting engineer, in the Nova Scotia Bank Bldg., St. Catharines, Ont. Previous to going west, he was on the metallurgical staff of the Canadian Copper Co.

Dr. Claude S. Hudson, of the U. S. Bureau of Chemistry, was recently presented with the William H. Nichols Medal for distinguished research work at a meeting of the New York Section of the American Chemical Society, held at the Chemists' Club. The presentation was made following a dinner at the club attended by more than 200 members of the society.

W. Frank Roberts has been appointed a vice-president of the Bethlehem Steel Co., with general charge of the operation of all steel works. He began work as a boy and for six years had the advantage of the training of an admirable master, the late Eckley B. Coxe, in whose office he was. Later he entered Lehigh University and after graduating became connected with the Bethlehem Steel Co., holding various positions.

The Snyder Electric Furnace Co., of Chicago, recently added to the staff of metallurgical engineers Robert M. Keeney, who will be in charge of all development work. Mr. Keeney has had a broad experience in electric-furnace research, covering the production of iron, steel and ferroalloys in the electric furnace, and the electric smelting of lead, copper and zinc ores. Before his connection with the Snyder Electric Furnace Co., Mr. Keeney was Electrometallurgist of the U. S. Bureau of Mines, at Pittsburgh, Penn., and Salt Lake City, Utah.

OBITUARY

Fred Richards, underground superintendent of the mines of the Newport Mining Co. on the Gogebic Range, was fatally injured in the Woodbury shaft on Mar. 8. He died the following day. He was in one of the buckets with Captain William Bond and Captain Griggs when he was struck on the head by a plank that fell from the staging above. A break in the compressed air line in the shaft caused the plank, which was not nailed, to fall. Mr. Richards was 31 years of age and a native of Cornwall, England. He learned his mining with the Newport company, starting work at an early age. He leaves a wife and one child.

Col. Alfred Hicks died at his home in Pittsburgh, Mar. 7, aged 79 years. Born in Wales he was brought to this country when five years old, and was brought up in Pittsburgh, going to work in an iron mill at Blairsville, Penn., when a boy. After serving with credit in the Civil War, he entered into business and was identified with many coal companies, having mines in the lower Allegheny Valley. In 1900 he organized the Allegheny Iron and Steel Co., whose plant is at Tarentum, and the Inter-State Steel Co., of Pittsburgh, which was later merged into the Allegheny company. He retired from business some years ago. He leaves a widow, a daughter and two sons.

SOCIETIES

American Chemical Society—The fifty-second meeting of the American Chemical Society will be held at the University of Illinois, Urbana-Champaign, from Tuesday, Apr. 18, to Friday, Apr. 21, inclusive. The Beardsley Hotel, Champaign, has been chosen as headquarters. Edward Bartow is chairman of the committee of arrangements. The program includes visits to manufacturing plants and coal mines, including Hegeler Brothers zinc-smelting and sulphuric-acid plant at Danville.

Canadian Mining Institute—The officers of the Institute for 1916 are as follows: President, Arthur A. Cole, Cobalt, Ont.; vice-presidents, Charles Fergie, Montreal, and Thomas W. Gibson, Toronto; Councillors, Alberta, R. H. Morris, Pocahontas, and Lewis Stockett, Calgary, British Columbia, Thomas Graham, Victoria, Gomer P. Jones, Hedley and M. E. Purcell, Rossland, Ontario, Norman R. Fisher, Cobalt, A. D. Miles, Copper Cliff, W. E. Segsworth and Clifford E. Smith, Toronto; Quebec, John A. Dresser, Montreal.

American Society of Mechanical Engineers—The Entertainment Committee of the New York Section has arranged a dinner to be given to the members and their guests at the Machinery Club, 50 Church St., on Wednesday evening, Mar. 29, at 7:30 p.m. The purpose of the dinner is to provide a purely social occasion when the members of the Section may become better acquainted with a view to making membership in the Section a social bond as well as a professional one. The dinner will be informal. The speeches will be social, rather than upon set professional topics.

American Institute of Mining Engineers—The next meeting of the New York Section will be held Mar. 23, at the Machinery Club, 50 Church St. The meeting will be preceded by a dinner served at 6:30. Following the dinner Frank J. Sprague, Chairman of the Committee on Electricity and Shipbuilding of the Naval Consulting Board, will speak on some phase of the Naval Problem. Mr. Sprague has recently returned from a cruise on the battleship "New York," witnessing the manoeuvers of the Atlantic fleet.

The Chicago Section held its annual meeting at the Engineers' Club, Chicago, Mar. 9. After dinner C. G. Atwater spoke on "Byproducts of Coal Distillation." At the business meeting the following officers were chosen: Chairman, Chas. H. MacDowell; vice-chairman, Luther V. Rice; secretary-treasurer, H. W. Nichols; additional members of the executive committee, Geo. P. Hulst, Alex. K. Hamilton, Frederick T. Snyder, Henry P. Howland.

Editorial Correspondence

SAN FRANCISCO—Mar. 8

The Embezzlement Charge Against William S. Noyes, president of the Presidio Mining Co., has been taken to the California Appelate Court on a writ of habeas corpus. Noyes was charged by the stockholders with misuse of money received from sale of stock. The case is not a clear one and comment should be withheld until evidence may be adduced to prove that an otherwise honest man of good repute among mining men is really guilty of a criminal act. It is not improbable that Mr. Noyes may have committed the offense of using his own judgment instead of misusing money of the company.

Coinage by the San Francisco Mint since its organization in 1854 and to and including Dec. 31, 1915, amounted to $2,000,591,286.87. The gold coinage amounted to $1,727,173,433.50; silver, $189,240,371.65. The total minor coinage, including 5c. and 1c. pieces, amounted to $759,410. Of the total amount of coinage in the period named, $1,917,173,215.15, was U. S. coinage; foreign coinage, $83,418,071.72. During the Panama-Pacific International Exposition, the mint issued octagonal $50 gold pieces to the amount of $75,450 and round $50 gold pieces, $75,500. There were quarter eagles to the amount of $25,042 and $1 pieces to the amount of $25,034. There were also $30,000 in silver half-dollars in honor of the Exposition.

Creation of a Trusteeship covering all the shares of stock of the Union Oil Co., the Union Provident Co. and the United Petroleum Co. has been undertaken as a solution of difficulties of the Union and its allied companies. The Los Angeles Trust and Savings Bank is suggested as a depositary for the stock and agent for the trust when not less than 170,462 shares, have been subscribed, which is equivalent to a majority of the issued stock of the Union Oil Co., proceedings will then be instituted for the dissolution of the holding companies. It is proposed that the stock should be trusteed for a period of seven years and that nine representative stockholders be elected voting trustees; the depositing stockholders to have the right to instruct the trustees concerning voting of the stock. The purpose is to so reorganize the management that all the stockholders of the three corporations shall be given present opportunity to participate in the companies, complying with the expressed wish of Lyman Stewart. The committee proposing the consolidation of interests and management is composed of A. P. Johnson, Lyman Stewart, John Groose, John R. Haynes, W. L. Stewart, Mrs. May K. Rindge, Giles Kellogg, A. W. Redman and Shirley C. Ward.

Plans to Merge a Number of California Oil Companies have not been abandoned, according to recent report. During a recent visit to Los Angeles, Mark L. Requa conferred with W. L. Stewart, president of the Union Oil Co., L. P. St. Clair, president of the Independent Oil Producers' Agency and other prominent producers. It is believed that the present plans contemplate the inclusion of new companies that may enter in the Pan-American Transport Co., which was originally formed for the purpose of merging the interests of California oil companies, including the Union. Although the original plans failed of consummation, the company was organized under direction of Edward L. Doheny, president of the Mexican Petroleum Co. So far as the Union was concerned, its inclusion in the original merger was prevented by the objection of Andrew Weir, of London, who is a heavy stockholder. It is understood that the failure of the Union to enter the merger precluded or prevented other California companies from going into the combine.

Regulation of the Oil Industry by the State Railroad Commission is advocated by the president of the Independent Oil Producers' Agency. Mr. St. Clair contends that the placing of the industry under control of the commission is the only logical solution of the problems of the oil trade; that it would prove a benefit to producers as well as consumers and insure the placing of the industry on a more stable basis, and at the same time the people would be amply protected. A bill was presented to legislature two years ago providing for such control by the Railroad Commission, but it did not meet with the support to which the proponents believed it was entitled. The subject is entitled to careful and thorough investigation and consideration. The railroads have a great deal, in fact, have the most, to do with the oil trade relations of the producers and consumers; and such legal control or regulation might well be taken care of by that commission. If, however, there should be added to its duties the labor of regulating the transportation and marketing of petroleum, the expansion of the commission will be greater even than some of the proponents of the measure themselves comprehend. The organization of a new branch of the commission to attend to this new work may therefore be the solution of the problem.

"Enthusiasm of Our Advertising Writer" is the excuse made public by the Golconda Consolidated Mines, an Arizona corporation, for issuing misleading advertisements, after being permitted by the corporation commissioner of California to sell stock in this state. The company secured a permit to sell 100,000 shares in California and subsequently published display advertisements which the commissioner says greatly misrepresented the condition of the company and the character of the property owned by it. The company was notified that the permit would be revoked unless another display advertisement were published clearly representing the condition and character of the company and its property, correcting the mis-statements and advising the public to disregard the misleading advertisements. The company followed the suggestions and laid the blame on the ad-writer. Commissioner Carnahan declares that as one of the most important functions of the administration of the blue-sky law is to prevent circulation of fraudulent or misleading advertising, he will inforce vigorously the provision of the act, making it unlawful to publish or circulate any advertisement relating to the sale of securities unless a copy shall first have been filed with the commissioner. He will not regard the enthusiasm of advertising writers as sufficient excuse for false statements or violation of the law, as the principal officers must be held responsible for the act of their employees and agents.

BUTTE—Mar. 9

Every Part of the Butte District is the scene of unusual activities. In the extreme north Butte section, the Butte & Great Falls Co., with its new equipment installed and shaft sunk to the 500-ft. level, has started to crosscut to the Genevieve vein, expecting to complete this work within 60 days. At the Badger State, most northerly of 22 operating shafts of the Anaconda, large quantities of zinc ores are being mined. The acquisition of the Pilot Butte by the Anaconda has given it another big zinc producer. The work of hoisting the ore from its different levels will now be transferred to the adjoining Badger State and the old Pilot Butte shaft will be used mainly for air.

The February Payrolls Proved to Be Record-Brenkers, being the largest for any month in the history of the Butte camp. Anaconda's payroll exceeds $1,200,000; that of the Butte & Superior is approximately $235,000, North Butte's is $120,000, and Elm Orlu, Timber Butte and other Clark companies have a payroll of about $75,000. East Butte's payroll is close to $50,000. Payrolls of the Tuolumne and Pilot-Butte are $20,000. Butte-Ballaklava, Butte & Zenith City, Butte & Great Falls, Bullwhacker, Davis-Daly and other smaller concerns have an estimated payroll totaling $50,000 to $75,000. This makes the total paid out by the Butte mining companies alone about $1,800,000. This does not include payrolls of any of the other industries and transportation lines connected with the operation of mines.

Operation of the New Compensation Law is proving most satisfactory to everyone except the lawyers who formerly got fat off the fees realized from damage cases. In the Pennsylvania mine fire, 21 men lost their lives. Under the Montana compensation law the dependent relatives were entitled to either $10 per week for 400 weeks, making a $4,000 total, or to a cash settlement of $3,380. The option of settling a cash amount on the beneficiaries is left to the state board that has the direction of the law in its hands. This board receives the claims, makes a thorough investigation of each case and then acts as a mediator in many instances. It inquires carefully into the plans of the widows and orphans and if in the opinion of the board, the beneficiary is not

capable of handling the money in a lump sum wisely, it orders the payment of the weekly indemnity extending over a period of eight years. It is reported that in this case every one of the beneficiaries asked for a lump sum as provided.

DENVER—Mar. 9

Arkansas Valley Smelters' Strike Is Virtually Ended. The plant is running with a full force of men, operating five furnaces and all the roasters. On Mar. 8, representatives of the American Smelting and Refining Co. submitted a plan to the State Industrial Commission in Denver, in which the company agrees to rectify all complaints of its laborers with the exception of the demand for an increase in wages of 5c. per hour. The commission plans to visit Leadville, Mar. 20, after matters have become normal, and will then make a thorough investigation before rendering a decision.

Efforts to Suppress High-Grading are being continued by the Colorado Mine Owners' Association at the instance of this Cripple Creek District organization. The last legislature passed a stringent law for the licensing of ore buyers, the intention being to strike thus at sales of stolen ores. A few days ago, one C. C. Schwerdt was arrested as he was leaving the U. S. Mint in Denver after disposing of $265 worth of gold said to have been "high-graded." His case will come up soon at Colorado Springs. Henry Lambert, well-known miner of the district, was arrested in Victor, Mar. 3, charged with storing quantities of pluverized rich gold ore in his home.

El Paso Gold Mining Co.'s "Independent Stockholders" committee met in Denver Mar. 5 and issued a circular expressing dissatisfaction with the management of the company, among other things charging the Golden Cycle interests with dominating the El Paso company's policies and activities. Proxies were asked to be voted at the annual meeting, covering the following proposed demands: Cessation of Golden Cycle control; the preparation of a geological report on the property; an effort to make greater profits from production; oil-flotation equipment; and a repeal of the "coat of whitewash" given former president, A. L. Burris, at the last annual meeting. The chairman of this grievance committee is C. J. Starke.

SALT LAKE CITY—Mar. 9

The Increased Activity in mining and other industries in this section is reflected in the February bank clearings of Salt Lake City. These amounted to $32,036,379, as compared with $21,439,541 in February, 1915, being an increase of 49.4 per cent. This is the largest increase shown by any city west of the Mississippi, the nearest to it being Stockton, Calif., with an increase of 39 per cent. All sections of the country showed an increase in this month, New York City being the greatest with an increase of 71.4 per cent.

The Daly-Judge at Park City is considering the erection of a plant for the treatment of its zinc ores. Two sites are under consideration for the plant, one at Deer Valley, the other on the flats below Park City. The ores, largely sulphides, are to be roasted, leached with sulphuric acid, and the zinc precipitated electrolytically. Cheap electric power will be obtained from Snake Creek Tunnel, owned by the company. Such a plant operating during 1915 would have practically doubled the earnings of the company, due to lessened cost of treatment and the greater price received for electrolytic spelter. A meeting will be held in the near future to consider the new project. The company has a large record of zinc production, and recent development has put an increased tonnage of ore of this character in sight.

JOPLIN, MO.—Mar. 4

Several More Sales Were the Features of the Week in this district. The Tom C. mines at Prosperity, owned and developed by T. F. Coyne, were sold to Roland R. Conklin, of New York, the announced purchase price being $175,000. The property consisted of a 12½-acre lease and two 200-ton concentrating plants. The Wilson mine at Duenweg, one of the older producers in the southern part of the Webb City-Duenweg sheet-ground district, was sold to the Onamena Mining Co. for $100,000. The Onamena company already is operating a 300-ton concentrating plant a short distance to the northwest of the Wilson mill and some of the principal owners of this property were operators of the Wilson mine. The Cinamo mine at Prosperity was sold by J. Harry Lindeman, of Joplin, and Leo H. Beckman, of Cincinnati, to J. A. Brennan, of Gary, Ind., and W. L. Brennan, of St. Louis, for a reported price of $100,000. This mine is just west of the Tom C. property and consists of a 10-acre lease and a 200-ton concentrating plant just completed. The J. W. Allen tract at Spring City, consisting of 240 acres, was sold during the week to the Joplin Zinc Metals Corporation for $125,000.

TULSA, OKLA.—Mar. 9

Laws Prohibiting Use of Natural Gas for Zinc Smelting may result from a movement inaugurated here. It is asserted that 90% of the gas used in zinc smelteries for fuel is wasted, and one local newspaper asserts editorially that more than one-half of all the enormous Kansas gas supply has been wasted at the Iola smelteries. Those behind the movement argue that the gas should be conserved for domestic consumption, and it would last many years for this purpose, whereas it will be a thing of the past in a year or two if the smelters continue to use and waste it.

ISHPEMING, MICH.—Mar. 13

That an Effort May Be Made to Open the Harbor at Escanaba, Mich., so that shipments of ore can be made by boats, several large ice crushers will be taken to the port for that purpose. There is a shortage of iron ore at several of the furnaces at Milwaukee, Gary and South Chicago. If it is possible to start boats moving, ore shipments will be made from the Gogebic and Menominee ranges. It will not be possible to get through the St. Mary's River and the Sault Ste. Marie locks for at least another month unless a channel is forced. There has been some talk of trying to break through the ice in the St. Mary's River but it is not believed that such a course will be adopted. The Pittsburg Steamship Co. started the move to force through the ice at Escanaba and other shippers and the railroad will help. The haul from the Gogebic to Escanaba is a long one but the ore is badly needed at this time.

MORENCI, ARIZ.—Mar. 10

Record-Breaking Ore Shipments are reported in Arizona. During the six days ending Feb. 26, the Humboldt and Clarkdale smelteries shipped 1,300,000 lb. copper bullion, valued at $364,000. In the same period the Humboldt received 49 carloads of ore from the Bluebell, 18 from the De Soto; the Clarkdale smeltery received 12 from the Commercial and 15 from the Copper Giant mine, in Mohave County. The United Verde Extension shipped 14 carloads to Douglas; the companies along the Arizona & California R.R. shipped 20 carloads to different plants. The S. F. P. & P. handled 150 carloads, which breaks all records. The State Corporation Commission has notified the zinc producers in the Chloride district, Mohave County, that notification of a materially advanced freight rate on zinc ore from Chloride to Colorado has been received by the commission. Operators were asked if they desired application be made to the Interstate Commerce Commission for suspension and investigation of the change.

PERTH AMBOY, N. J.—Mar. 15

A Uniform 8-Hr. Day with increased pay to their employees, aggregating several thousand men, has been granted by both the American Smelting and Refining Co. and the Raritan Copper Works. The American Smelting and Refining Co.'s action follows an increase of 1c. an hour in the wages of employees granted Aug. 16, 1915.

JEFFERSON, N. C.—Mar. 11

Interest in the Mining Possibilities of Ashe County has been stimulated by the first season's operation of the extension of the Virginia-Carolina R.R., from the Norfolk & Western main line, at Abingdon. Since last November a field party has been engaged in making a magnetometric survey of the iron deposits of Ashe County. It is understood that the work is being done for the Virginia Iron, Coal and Coke Co., of Roanoke, which owns a large area covering the Ballou lead, and has taken options on other tracts. It is reported that other parties will operate some of the properties, making shipments to the Johnson City furnace. These magnetic iron deposits have been investigated before, and some surface work and drilling done. Recently a talc property on Beaver Creek has been optioned to outside parties by W. R. Copenhaver, of Abingdon. The talc and soapstone deposits are extensive and have been operated for local needs for a long time.

PEKING, CHINA—Feb. 10

The Imperial Mandates Officially Announce that G. G. S. Lindsey, K. C., has been asked to undertake, and has accepted the task of drafting new mining laws for China. Mr. Lindsey has been in Peking for the last year supporting a grant of a mining concession to large European interests and has finished his work in this connection. By various treaties, some as old as 1902, the Chinese Empire undertook to promulgate mining laws satisfactory to the Treaty Powers, but so far has been unable to do so. Now in fulfillment of its earnest desire to carry out its obligations and to induce foreign capital to come to this country for mining purposes, new laws are to be promulgated. It is expected that they will be drawn up according to modern mining requirements and on a liberal basis with the object of throwing open Chinese mineral resources to the world.

The Mining News

ALASKA

INDEPENDENCE (Willow Creek)—Will install 40-stamp mill in spring with other equipment.

ALASKA MEXICAN (Treadwell)—Production for January from 19,775 tons crushed was 443 tons concentrates, valued at $15,233; total production, $26,886.

ALASKA UNITED (Treadwell)—Production for January from 45,395 tons crushed was 1,007 tons concentrates, valued at $43,117; total production, $92,592.

ALASKA TREADWELL (Treadwell)—Production for January from 78,677 tons crushed was 1,500 tons concentrates, valued at $55,305; total production, $126,510.

MINERAL CREEK (Valdez)—Claims will be worked this year by the purchasers at Marshal's sale two years ago. New stamp mill will be installed with other machinery.

KENNECOTT COPPER (Latouche) — Beatson property being rapidly equipped for greater tonnage. Additional 150 men will shortly be put to work at mine and mill.

PATTON (Valdez)—W. E. Patton, of Spokane, will open up claims prospected by Patton Mines Co. on the Ft. Liscum field. This involves hydro-electric plant, mill and other equipment. Reported that Patton will install milling method of his own, successful in treating ore of similar character.

ALASKA GASTINEAU (Juneau)—Tapping the lake at Annex Creek Power Plant accomplished, using drills to last round, pilot holes having been drilled ahead with diamond drill. Valves used on last round and where water hammer drill holes went into lake these valves prevented flooding of tunnel. This tapping drains water of upper Annex Lake through 1,300-ft. tunnel to pipes leading to power house on beach, 800 ft. below. While tunnel was being concreted, company obtained power by use of dam and bypass pipe to the water lines. Work on the 4,000-hp. unit started last May now finished.

ARIZONA

Cochise County

SHATTUCK ARIZONA (Bisbee)—Production for February was 1,523,137 lb. copper, 499,155 lb. lead, 27,139 oz. silver, and 610 oz. gold.

DENN-ARIZONA (Bisbee)—Stockholders, encouraged by ore on 1,600-ft. level, are considering resumption of operations. Thought there is no more than 150 ft. water in mine.

COPPER QUEEN (Douglas)—Smeltery output for February, 12,690,000 lb copper; exceeding output for January by 700,000 lbs. Figures include copper from custom ores and concentrates from Nacozari.

SHATTUCK (Warren)—Daily output is 450 tons copper ore, shipped to Douglas smelter and 100 tons silver-lead ore, shipped to El Paso. Silver-lead ore found at 200 level, copper glance at 300 and 2% vanadium at 600 level.

BUNKER HILL (Tombstone)—Shipping 10 carloads of manganese concentrates direct to the steel plants of New Jersey and Pennsylvania. Three shifts worked in Oregon shaft; ore hauled on motor trucks to mill going at full capacity; about 400 men employed.

Gila County

INSPIRATION (Miami)—Material ordered for two additional units to mill, making 20 in all, increasing daily capacity from 16,200 to 18,000 tons.

GRAYSTONE (Miami)—While digging trench workmen discovered vein of high-grade copper. Fifty tons shipped and more coming; Graystone is 12 mi. west of Miami.

NORTHWEST INSPIRATION (Miami)—E. F. Eisenhour and associates have organized Northwest Inspiration Copper Co. to develop Miner and Rose groups of 27 claims adjoining Inspiration.

Greenlee County

ARIZONA COPPER, LTD. (Clifton)—Production for February was 1,207 tons copper.

Mohave County

FRISCO (Kingman)—Frisco Gold Mines located Union Pass section, 24 mi. west Kingman, to be reopened.

Pima County

YUMA (Tucson)—Machinery for treating molybdenum ore is being installed.

BUSH-BAXTER (Tucson)—Daily shipments to El Paso average 120 tons; opening new level at 250 ft.; ore runs 4% copper; total shipments since the American Smelting and Refining Co. took over the property several months ago, 15,000 tons.

AMERICAN SMELTING AND REFINING (Silverbell)—Has bought Silverbell mine from defunct Imperial Copper Co. Silverbell has been closed down since 1910; comprises 60 patented claims, millsite, smelter site, and 1,820 acres land; ores will not be treated in the old Sasco smeltery as formerly, but will go to Hayden plant.

Pinal County

EMPIRE ZINC (San Xavier)—Company has announced that it will resume operations at San Xavier mine and will erect reduction plant.

PINAL DEVELOPMENT (Ray)—Company developing Renfro property, 4 mi. east of Ray Consolidated mines, reports new strike of rich ore made on heretofore unexplored ground.

Santa Cruz County

PROGRESSIVE (Nogales)—Purchased by Sawyer and Browder, who have sunk two shafts to depth of 80 ft. Shafts have opened 5-ft. vein $30 ore; old mill being reconstructed and arrangements made for erection of cyanide plant.

Yavapai County

EUREKA (Poland)—Major Mining and Milling Co. has purchased Poland mill to treat Eureka ores.

MILDRED (Stanton)—Crosscut will be driven 200 ft. from tunnel to tap known orebody; reported mill will be built.

VERDE RIVER COPPER (Mayer)—Contract let for several hundred ft. tunnel work; plans sinking soon. Verde River controlled by A. L. Garford, automobile manufacturer.

POCAHONTAS (Mayer)—Operations resumed; will probably commence producing ore when new plant of Gray Eagle Reduction Co. at Mayer is in operation. W. H. Skinner, manager.

UNITED VERDE COPPER (Jerome)—Has increased wages 50c. a day to all employees, increasing daily payroll by $1,500. This is third raise (totaling in all $1 per shift) employees of United Verde have received since copper reached 25c. point.

UNION (Chaparral)—A 16-ft. crosscut on 175-ft. level of old shaft has disclosed 6 ft. of free milling and concentrating ore. New vein thought to be parallel with rich vein tunnel was supposed to reach at distance of 136 ft. Union mill operated on ore from new strike with highly satisfactory results.

UNITED VERDE EXT. (Jerome)—Annual report for 1915 states that 3,579 tons averaging 43.9% copper was taken from chalcocite vein in southerly end of original five claims; also 6,173 tons averaging 17.6% copper taken from same body. Options secured on 39 claims, about 590 acres, adjoining original five claims on the southeast; all ore now shipped to Douglas smelteries, 470 mi.

CALIFORNIA

Amador County

CHROME DEPOSITS discovered by V. N. Swanson, reported to contain 40% ore. Lease reported taken on 300 acres, embracing chrome and thorough development contemplated. Estimated ore can be placed on cars at a cost of $5 a ton.

CONSOLIDATED AMADOR (Sutter Creek)—Pumping machinery arranged for by Mr. Beam on recent visit to San Francisco. He is reported as stating that proposed initial amount of $1,000,000 for purchase and development was over-subscribed. Among the subscribers to this amount are reported W. E. Corey, John D. Ryan, Thomas Cole, Ambrose Monell and John B. Farish.

Calaveras County

CHROME DEPOSITS reported discovered near Copperopolis, by C. H. McClory, of Angels Camp and J. F. Bollinger of Copperopolis. Surface cropping reported 8 ft. wide. Property has been bonded to company formed for development.

Nevada County

EL ORO (Lake City)—Fred Phelps, manager arranging for installation of a hoisting and pumping plant. Construction of headframe progressing.

ORMONDE (Washington)—Reported bonded to San Francisco men and that extensive development will be undertaken. Mine equipped with 20-stamp mill and other machinery, much of which will have to be replaced by modern machinery.

Placer County

BLUE LEAD (Dutch Flat)—Reported that S. C. Jordan who has been examining the property since last fall has pronounced favorably. Stamp mill ordered and the foundation work started. Development employing 20 men, more will be employed later.

Plumas County

PLACER MINING on Squirrel Creek reported prosperous and some very coarse gold washed out. Byron Turner recently took out a nugget weighing 1½ lb. valued at over $400.

San Benito County

NEW IDRIA QUICKSILVER (Idria)—Shipped 500 flasks recently. Costs reported $50 per flask including exceptional mine development expenses.

Shasta County

VICTOR POWER AND MINING CO. (Knob)—Directors decided upon placing president J. H. Sharpe at the mine in Harrison Gulch, as manager. New vein disclosed on 200 has also been opened on the 500 level. New Lane mill has 80 tons per day capacity and is working up old Midas dumps.

Siskiyou County

CLEAR CREEK (Happy Camp)—About 1,000 ft. of development work indicates large bodies of ore.

TIMBERLINE (Happy Camp) — High-grade ore reported showing 8% copper and $5 per ton gold and silver. Large orebodies indicated.

NEALONE (Happy Camp) — Crosscutting has disclosed bodies of pyrites about 40 ft. wide, including deposits said to contain over 6% copper and $4 gold and silver per ton.

MILNE (Hamburg Bar)—After cleaning up $400 in 10 days from this hydraulic mine owner George Milne, obliged to shut down account of freezing weather. Milne took out one nugget valued at $500.

Tulare County

CALIFORNIA MAGNESITE CO. (Porterville)—Treatment plant will be doubled in capacity and chemical laboratory installed. In addition to testing ores produced by company, the laboratory will also serve prospectors and miners in district by making the determinations without charges.

Tuolumne County

IF I CAN (Jamestown)—Reported that a rich strike has been made in this gravel mine on Stanislaus River. Property acquired by J. C. Prentice 2 or 3 years ago; has been fairly well developed since it was reopened by him.

Yuba County

YUBA CONSOLIDATED (Hammonton)—No. 15 new all-steel 16-cu.ft. dredge, whose hull has been in course of construction during winter, reported launched Mar. 15.

A. B. C. (Brownsville)—Operations resumed and arrangements made for installation of new process cyanide plant, with capacity of 150 tons of ore per day. Mine equipped with 5-stamp mill, which will be increased to meet the requirements of cyanide plant.

COLORADO

Boulder County

COLUMBIA (Ward)—Property being developed by McGinnis, Wolf & Co. Large ore shoot recently opened. A 2-ft. vein of sulphide ore opened in Sullivan No. 5. Planned to unwater other properties in neighborhood to explore for tungsten ores.

Clear Creek County

PORTLAND (Dumont)—A pocket of rich gold ore has been struck in the shaft. J. W. Smith is manager.

EUREKA (Boulder Falls)—Purchased by Degge and Wolcott who will begin development at once. Three sets of leasers now at work carying on successful exploration.

Lake County

EAST CARBONATE HILL SECTION (Leadville)—Area including Mikado, R. A. M., Pyrenes, and Greenback mines will be drained by new company with reported capitalization of $12,000,000, management of George O. Argall. Preliminary work underway at Pyrenes shaft, 1,000 ft. deep, water at 500 level; shaft sinking planned following drainage.

San Juan County

GOLD KING (Gladstone)—Snowslides damaged compressor plant, blacksmith shop and upper tramway terminal.

San Miguel County

TOMBOY (Telluride)—During February mill ran 27 days, crushed 12,000 tons yielding $36,000 bullion, shipped $51,000 concentrates. Expenses were $59,400, leaving net profit of $27,600.

IDAHO

Shoshone County

RAY-JEFFERSON (Wallace)—Carlisle vein cut in lower tunnel at depth of 300 ft. below former workings, disclosing large body zinc-lead ore. Vein encountered near intersection of Carlisle and Ray-Jefferson veins. Tunnel in which strike was made is to be main outlet to mill now being constructed.

WEST HUNTER (Mullan)—Stewart Mining Co. recently took option on control of this company owning group of claims lying between the Morning and Hunter and joining the Independence on south. Stewart company thought to be acting in harmony with Independence, and that properties will eventually be consolidated. Independence reported to have developed large amount ore on extensions of Morning veins, and West Hunter would be a valuable addition for buildings and surface operations aside from mining value. Option calls for expenditure of upward of $20,000 in developing West Hunter.

MICHIGAN

Copper

COPPER RANGE (Trimountain)—Company's Trimountain mill partially destroyed by fire Sunday evening, Mar. 12; loss $200,000, covered by insurance.

OSCEOLA (Osceola)—North Kearsarge No. 4 reported getting into good rock in lower openings, as it enters Allouez zone.

CALUMET & HECLA (Lake Linden)—Output of tailings-treatment plant in January said to have been 382,155 lb. fine copper.

ISLE ROYAL (Houghton)—New stamp mill giving satisfaction both as to capacity and recovery; latter about 14 lb. per ton.

TORCH LAKE (Houghton)—Reported that exploration operations will be started soon. Property owned by Boston and New York capitalists headed by Thatcher Loring.

Iron

IRON RIVER—J. S. Kinney has started drilling on Section 7, a quarter mile south of Zimmerman mine.

WAKEFIELD (Wakefield)—Shovels are ready to start as soon as boats can get to Ashland, Wis. Considerable work done in underground mines this winter.

DOBER (Iron River)—Fire out and mine again free from gas after burning several weeks. It was smothered by stopping all openings. Mining will be resumed shortly.

TOBIN (Crystal Falls)—Water level lowered to 12th level; ore now being hoisted. Work of draining was started first of year. The 13th level will next be drained. About 150 men working; more being added daily.

HANOUSACK (Wakefield)—Stripping going ahead at rapid pace, work starting from Wakefield pit. Large shovels did such fine work at Nashwauk, Minn., last year that one 315-ton shovel was purchased for this stripping job and is being used.

LAKE ANGELINE (Ishpeming)—Electric hoist has replaced steam plant at the Happy Hollow workings. Considerable ore being taken out. Small area at east end will be stripped this summer, orebody there being only 10 ft. under surface.

MINNESOTA

Mesabi Range

HOLLAND (Biwabik)—Operations are to be resumed. About 200,000 tons have been sold.

COLERAINE—Large tonnage will go forward from Canisteo district this year, according to officials of the Oliver Iron Mining Co.

WILLIAMS (Biwabik)—Mine is to be reopened, after idleness of two years. Stockpile will be moved this year, ore going to Milwaukee.

QUINN-HARRISON (Nashwauk) — Butler Bros.' 315-ton shovel has been moved onto property from Mace No. 2, and 200 men will be put to work at once.

ACTURUS (Marble)—Three shovels working day and night to get this mine ready for production, work started last fall. Spur tract constructed from mine to Hill repair shops.

BIWABIK (Biwabik)—Decided to do considerable stripping this spring. Orebody remaining in pit will be uncovered. Large ore sales have been made. Some development work done during winter.

Vermilion Range

SEC. 30 MINING CO. (Vermilion Range)—A Myers-Whaley shovel will be installed in pit. This machine, capacity 60 tons per hour, can later be used in underground work.

MISSOURI—KANSAS—OKLAHOMA

FRANKLIN (Prosperity, Mo.)—Company will erect 400-ton concentrating plant on Boston-Get-There land.

WELLS (Duenweg, Mo.)—Company rebuilding Overland mill north of Duenweg and adding separate sludge department.

ZINC CORPORATION (Carterville, Mo.)—Old Virginia mill, of 350 tons capacity, just completed by J. F. Dexter on the Cornfield tract, and started up.

LULU V. (Spring City, Mo.)—Centrifugal pump installed similar to that already on neighboring Delta No. 2. Mines have been flooded since heavy rains 60 days ago.

TRINITY ZINC (Duenweg, Mo.)—Barnett Mining Co. has taken lease on Whitsett and Chapel mines and will remodel mill and connect the two properties with an aërial tram.

EVANS-HALL-SOY (Duenweg, Mo.)—Will build 250-ton mill on C. T. Orr land at site of old Rosebud. Recent developments indicate large body sheet-ground ore.

BATESVILLE (Neck City, Mo.)—Mine, formerly known as Second National, taken over by Toledo-Joplin Mining Co., which also has purchased Joplin Concentrating Co.'s mill on adjoining tract.

COAHUILA (Joplin, Mo.)—Has contracted for erection of 1,000-ton concentrating plant near its present mill north of Duenweg. A 16x42 Corliss engine ordered. Five 150-hp. high-pressure boilers will be installed, and a 1,200-cu.ft. Sullivan straight-line compressor.

ADMIRALTY ZINC (Cardin, Okla.)—Two new concentrating plants being pushed to completion are expected to be in operation in few weeks. Company recently broke into rich dirt in one of the new shafts it is sinking.

BILHARZ (Cardin, Okla.)—Company, which recently took over Bluebird from Church and Maben, has started building second mill on the Shorthorn lease, adjoining that on which Blue Goose is making heavy production. One shaft already down to ore and another well underway. Company also drilling 80-acre lease from Chapman land and will develop if drilling results justify.

MONTANA

Granite County

ROYAL BASIN (Maxville)—Northwestern Mines Consolidated, present owner will start work. Property equipped with 250-ton concentrator and flotation plant. Concentrates will be shipped to Anaconda. Ore reserves estimated at 500,000 tons of 2% copper ore. Morris Stark, superintendent.

Mineral County

TARBOX (Saltese)—Drift from bottom of 400-ft. shaft has disclosed much zinc ore. Two shifts of men will be put on at once to do extensive development work.

Silver Bow County

CORBIN (Butte)—Directors authorized Mar. 7 to sell Gambrinus claims to development company. If consummated, sale will clean up floating debt and give Corbin stockholders substantial interest in new company.

DAVIS-DALY (Butte)—Report for last quarter of 1915 shows balance of $3,462.71, total receipts being $73,092 and expenditures $69,629. Ore shipped totaled 4,418 tons, averaging 7% copper and 7 oz. silver. Company has collected $8.50 per share on the new stock and is still liable to assessments for $1.50 per share.

BUTTE & SUPERIOR (Butte)—February tonnage approximated 55,000 from which was recovered nearly 16,000,000 lb. zinc. Efforts of management now centered on two new

shafts being sunk with most modern sinking machinery. Progress made in past 30 days leads to expectation that work will be completed in nine months time.

COLUSA-LEONARD (Butte)—Large stockholders of the Colusa-Leonard Extension Co. are attempting to get owners of some of adjoining properties to aid in bringing entire holdngs into shape for operating purposes. They have assurances, it is understood, that if this can be done, needed financial assistance can be secured to develop property. Colusa-Leonard owns a part interest in number of claims and fractions directly east of Leonard mine of Anaconda company.

ANACONDA (Butte)—Reports that company is negotiating for a number of properties in the Butte district, including the East Butte and North Butte, are declared by the company's officials to be without foundation. Emma surface plant progressing steadily. Foundations for new compressor and hoisting engine being placed. Shaft sinking to 1,600-ft. level will begin as soon as new hoist is ready. Latter will have capacity of 700 hp. and will handle ores from a 2,000-ft. shaft. New electric pump installed on 800-ft. level has capacity of 700 gal. and wil be able to take care of all future flow. Zinc ores opened up on the various levels are said to be of large extent and of high tenor.

NEVADA

Esmeralda County

GOLDFIELD CON. (Goldfield)—Final report for January shows a net profit of $59,061 from 31,000 tons treated. Total operating costs were $5.18 per ton and net costs $5.07 per ton. A total of 3,387 ft. development was done at $5.06 per ft. Preliminary estimate for February indicates a profit of $60,000. Gross yield placed at $221,000 from 29,400 tons treated, operating expenses being $161,000.

Nye County

TONOPAH ORE PRODUCTION for week ended Mar. 4 was 7,846 tons valued at $164,488 compared with 8,307 tons for week previous. Producers were: Tonopah Belmont, 2,662; Tonopah Extension, 1,800; Tonopah Mining, 1,600; Jim Butler, 750; West End, 500; Halifax, 110; North Star, 60; MacNamara, 40, and miscellaneous leases, 324 tons.

GREAT WESTERN (Tonopah)—Crosscutting on the 1,135-ft. level temporarily suspended because of heavy flow of water encountered. Pumps are being placed.

MACNAMARA (Tonopah)—Working through West End shaft as result of recent arrangement with latter company. Made an initial shipment of 40 tons to local milling plant.

TONOPAH EXTENSION (Tonopah)—At No. 2 shaft three compartment winze from 1,350-ft. level down to 1,440-ft. intermediate level and east and west drifts being run—all in ore. Drift 1,503 from 1,540-ft. level Victor shaft is beneath winze and raise has been started to connect. Drift shows full face of excellent ore.

Storey County

ANDES (Virginia)—Work continued on intermediate level near old Egan stope.

CROWN POINT-BELCHER (Gold Hill)—Saved 86 cars ore from raise in north drift 1,600 level. Jacket mill received 602 tons dump rock; idle part of week on account of storm.

UNION CONSOLIDATED (Virginia)—Extracted 454 tons, gross value about $8,000; largest tonnage from 2,400 level, north stope showed $34.75 per ton. Continued reopening 2,700 level south drift.

SIERRA NEVADA (Virginia)—Extracted 109 tons ore from No. 1 stope 2,500 level, gross value over $1,600. Necessary timbering and repairs made in winze. Joint shaft reopened 25 ft. to the 220-ft. point below 2,000 level.

MEXICAN (Virginia)—Prospecting crosscut on 2,500 and 2,700 levels continued in porphyry and quartz of low assay. East crosscut on 1,600 level cleaned out and now repairing to 500-ft. point. Mexican mill crushed 562 tons custom ore averaging $17.25; 6 bars bullion shipped.

OPHIR (Virginia)—Extracted 211 cars ore from Central tunnel and milled 260 tons. Work in stope temporarily suspended on account of caved ground in old workings. East crosscut started on 250 level. Joint west crosscut 2,700 level continues through vein formation; now out 404 ft. from winze station.

NEW MEXICO

Dona Ana County

ORGAN MT. (Organ)—Officers for ensuing year were elected as follows: J. I. McCullough, of El Paso, president; John H. May, of Las Cruces, vice-president; F. W. Campbell, Las Cruces, secretary-treasurer; James White and E. S. Semple, other directors.

Grant County

STAUBER & WRIGHT (Pinos Altos)—Electrostatic mill being operated by Ira Wright.

CARLISLE (Steeplerock)—Only the 500-ft. level and about 1,100 ft. of tunnels remain unwatered.

BURRO MOUNTAIN (Tyrone)—Construction work progressing rapidly at both mine and mill, latter nearing completion.

BLACK HAWK (Silver City)—Machinery being received for extensive operation in near future. E. D. Lindstone of El Paso is president.

OHIO (Pinos Altos)—J. A. Peterson has leased Ohio mine from Savanna Copper Co,, 500-ft. tunnel being cleaned preparatory to operation.

KING ZINC (Redrock)—Geo. W. Spencer developing property, reported discovery of 10-ft. vein of 40% zinc ore in crosscut tunnel on 100-ft. level.

NELLIE BLY (Lordsburg)—Fred Hickory and Joe Dulaney, of Dos Cabezos, Ariz., have purchased half interest in Nellie Bly, and operations will begin soon.

AUSTIN (Leopold)—Rich copper strike reported by Beal & Brown, leasing from Porterfield Bros., of Silver City. Carload of 26% copper is being sorted for shipment.

CHINO (Santa Rita)—Production for 1915 according to State Tax Commissioner was $11,383,777 net being determined by Commission as $6,846,204.

MAGDALENA COPPER CO. (Pinos Altos)—Company organized to operate Hardscrabble mine north of Pinos Altos recently held by J. T. Janes and associates.

85 MINE (Lordsburg)—Shipping steadily 400 tons daily to Douglas and El Paso smelters. Diamond drill exploration shows continuation of commercially valuable ore. Gross return during 1915 was $762,921; net $183,689.

Lincoln County

WHITE OAKS MINES (White Oaks)—Company reports $30,259 as gross output of mine in 1915. Wild Cat Leasing Co., reports $49,611.

Sierra County

SNAKE AND OPPORTUNITY (Hillsboro)—Big Diesel engine being put in shape for operation. P. H. Williams, in charge since acquisition by John M. Sully and associates, is hiring skilled labor and engineers at Hurley preparatory to beginning unwatering.

Socorro County

SOCORRO (Mogollon)—Company's gross production for 1915 was $619,127 according to tax commission.

WASHINGTON

Stevens County

NORTHPORT SMELTING (Northport)—Rebuilt plant blew in two furnaces Mar. 7. Third expected to be ready within 60 days. Between 150 and 175 men employed.

CANADA

Ontario

CROESUS (Munro Township)—Vein cut at 300- and 250-ft. levels.

WEST DOME CONSOLIDATED (Porcupine)—Work started on Mar. 6 will be steadily continued.

McINTYRE (Porcupine)—Accident in No. 5 shaft has postponed starting 150-ton addition to mill.

McCREA (Boston Creek)—Which is under option to the Crown Reserve of Cobalt, has struck high grade in shaft.

DOME LAKE (Porcupine)—Mill closed on Mar. 8 to allow installation of cyanide plant. Underground work proceeds.

TIP TOP (Port Arthur District)—Mine closed down for six years is again being worked and shipping ore to New York.

PEOPLES' (Cobalt)—Work to be resumed shortly. Arrangements made with Ophir to work both properties through one shaft.

O'BRIEN (Gillies Limit)—About 25 ft. drifting completed on galena vein at 200-ft. level, where vein continues wide and heavily mineralized.

DOMINION REDUCTION (Cobalt)—Has thrown up its options on Big Master and Laurentian properties in Wabigoon district.

MILLER INDEPENDENCE (Boston Creek)—Has installed a steam plant and started underground development. Nissen stamp will treat ore.

GIFFORD (Cobalt)—Machinery installed and mine being dewatered. Diamond drilling from 200 ft. level will be undertaken to determine extent of orebody.

R. A. P. SYNDICATE (Boston Creek)—Drifting being pushed on 100 ft. level and results reported satisfactory. Adjoining Hill claim has been purchased.

NIPISSING (Cobalt)—February ore mined has estimated net value of $171,856; bullion from Nipissing and customs ore shipped estimated net value of $309,320.

CHENEY COPPER (Thessalon)—Which is under option to Hollinger interest to have complete mining plant installed soon. Several cars high-grade being shipped to the States.

GENESEE (Cobalt)—Shaft down 60 ft. In drift running 60 ft. north of shaft, vein shows 2 to 4 in. wide with three narrow veins at right angles. Sinking will be continued to 300-ft. level.

VIPOND (Porcupine)—Report covering last year shows profit of $35,136 from the treatment of 35,899 tons, or a little less than $1 a ton. Ore reserves Dec. 31 amount to 90,000 tons valued at $587,280 or an average of $6.52 a ton. Costs were $4.95.

DOME (Porcupine)—February production $163,500 from 32,040 tons, or an average recovery of $5.10 a ton, a decrease of $13,490 value, but increase of 440 tons as compared with previous month. Excessive snow has interfered with operations of open pits.

CUBA

MATAHAMBRE COPPER (Santa Lucia)—The Ambursen Co. has been awarded a contract for a 6-mi. Lawson aërial tramway from the mines to the coast. Work will be commenced at once and completed inside of six months.

SOUTH AMERICA

Peru

SANTA BARBARA MERCURY DEPOSITS of Huancavelica may be opened up soon, according to the reported statement of Eulogio E. Fernandini, vice-president of the American Vanadium Co. For some years Santa Barbara mines have been in possession of General Avelino Cáceres and Augusto Benavides, whose interests have been purchased by Mr. Fernandini.

AFRICA

Transvaal

GOLD PRODUCTION IN JANUARY was: Witwatersrand, 759,852 oz.; outside districts, 27,615 oz.; total 787,467 oz., which is 6,356 oz., more than in December, and 44,868 oz., more than in January, 1915. The total number of negro laborers employed was 219,865, an increase of 986 during the month.

The Market Report

Metal Markets

NEW YORK—Mar. 15

Special features of last week were the continued rise in lead, and the continued decline in spelter. Toward the close, however, the latter rallied, and it looks now as if the bottom of the recent decline has been seen. Business in copper was light, but it was sufficient to produce a small advance in price.

Copper, Tin, Lead and Zinc

Copper—There was more business done than in the previous week, some consumers having been interested by their ability to obtain some relatively cheap copper. The transactions were chiefly for April-June and May-June delivery, but there were also some transactions for prompt metal. The premium that is talked about for the latter was more theoretical than practical. Apparently, the purchases were sufficient to clean up most of the supplies that producers were offering cheaply, and as the week progressed there was not only a better tone, but also slightly higher prices were realized. The principal producers have been indifferent to the market all along since the recession started, and the present outlook is that the market will return to their price. However, at the close copper was freely available from other producers at 26½@27c., r.t., according to delivery.

The New York, New Haven & Hartford R.R. raised its embargo at midnight, Mar. 10-11, and accepted shipments until midnight of Mar. 14-15, when the embargo was put into effect again.

Exports from Baltimore for the week included 50,020 lb. copper to Glasgow, Scotland; 2,240,597 lb. to Havre, France.

Copper Sheets are quoted at 34c. per lb. for hot rolled and 35c. for cold rolled. Copper wire is 28¾@29¼c. per lb. for carload lots at mill.

Tin—On Mar. 9 there was a spectacular advance in price for spot tin, and the market has ruled at high figures ever since then. The reason for this was the prevention of exports from London by the British Government, the motive for which remains unknown. A London cable today stated that permits are unobtainable, and it is impossible to get any tin out of England. In this market business was fairly active on some days, while on other days but little was done. The supply of spot tin in New York is very small.

Lead—A very large business for export to Japan and Russia was done, and the buyers for that purpose being willing to pay almost any price, the market advanced sharply. Most of this lead being shipped westward, St. Louis was the primary and principal market, and the price there ruled far above the New York parity. Exporters were able to sell in the neighborhood of 8c., f.o.b., Pacific ports—8⅛c. being the highest whereof we have heard—and the freight rate to there being 50c. per 100 lb., high prices could be paid in St. Louis market, and a large profit realized. The great demand for lead for export and the large premiums over its price that were being realized by outsiders, led the A. S. & R. Co. to advance its price to 7c., New York, on Mar. 14. At that price, and the corresponding prices for other points, the regular consumption on contracts is being supplied. However, consumers—even the large and important ones—who require lead in excess of their contract provisions, have been obliged to go into the outside market and buy it in competition with the exporters. At the close the lead market continues very strong. The basis of the recent advance is the large export demand. It is not believed that speculators and traders have played any great part in it. In that respect the conditions are quite different from those that prevailed during the spectacular advance last June.

Exports from Baltimore for the week included 444,476 lb. lead to Glasgow, Scotland.

Spelter—The weakness that was in evidence last week continued, and the market went down rapidly. Although the business transacted was not very large, it was nevertheless a good deal more than in the previous week, which was an encouraging sign. However, the market was under distinct pressure from certain important producers, other producers reporting quite generally that prospective business was taken away from them by lower offers. Business that was done was almost entirely with domestic consumers, chiefly with brass makers, the galvanizers buying very little. Neither France nor Great Britain was a buyer. The terms of the recent governmental regulation in France are not well understood here. It was supposed that the Government was going to undertake the buying of all spelter, but in the latter part of the week there was an inquiry in the market from at least one private French concern. British interests made inquiries, but did not buy. During the last day or two, the market stiffened considerably, and between morning and afternoon of

DAILY PRICES OF METALS IN NEW YORK

Mar.	Sterling Exchange	Silver, Cts. per Oz.	Copper: Electrolytic, Cts. per Lb.	Tin: Spot, Cts. per Lb.	Lead: New York, Cts. per Lb.	Lead: St. Louis, Cts. per Lb.	Zinc: St. Louis, Cts. per Lb.
9	4.7600	56¾	25¾ @26	55	6.60 @7.00	6.75 @7.00	15.50 @17.50
10	4.7613	56¾	25¾ @26	56	6.60 @7.00	7.00 @7.12½	15.00 @17.00
11	4.7625	56¾	25¾ @26	55	6.60 @7.00	7.00 @7.12½	14.75 @16.50
13	4.7613	56¾	26 @26¼	55	6.60 @7.00	7.12½ @7.37½	14.25 @16.00
14	4.7625	56¾	26¼ @26¼	54	7.00 @7.25	7.37½ @7.62½	14.25 @16.25
15	4.7631	56¾	26¼ @26¼	55	7.00 @7.50	7.50 @7.75	14.25 @17.00

The quotations herein are our appraisal of the average markets for copper, lead, spelter and tin based on wholesale contracts for the ordinary deliveries of the trade as made by producers and agencies; and represent, to the best of our judgment, the prevailing values of the metals, reduced to basis of New York, cash, except where St. Louis is given as the basing point. St. Louis and New York are normally quoted 0.17c. apart.

The quotations for electrolytic copper are for cakes, ingots and wirebars. Electrolytic copper is commonly sold at prices including delivery to the consumers and is subject to discounts, etc. The price quoted for copper on "regular terms" is the gross price including freight to the buyer's works and is subject to a discount for cash. The difference between the price delivered and the New York cash equivalent is at present about 0.25c. on domestic business. The price of electrolytic cathodes is 0.05 to 0.10c. below that of electrolytic. Quotations for lead represent wholesale transactions in the open market for good ordinary brands. Quotations for spelter are for ordinary Prime Western brands. Only the St. Louis price is herein quoted, St. Louis being the basing market. We quote the New York price at 17c. per 100 lb. above the St. Louis price.

Silver quotations are in cents per troy ounce of fine silver.

Some current freight rates on metals per 100 lb. are: St. Louis-New York 17c.; St. Louis-Chicago, 6.3c.; St. Louis-Pittsburgh, 13.1c.

LONDON

Mar.	Silver	Copper: Standard Spot	Copper: Standard 3 Mos.	Copper: Electrolytic £ per Ton	Copper: Electrolytic Cts. per Lb.	Tin: Spot	Tin: 3 Mos.	Lead: £ per Ton	Lead: Cts. per Lb.	Zinc: £ per Ton	Zinc: Cts. per Lb.
9	27	97¾	96	136	28.95	188	187¾	32¾	6.97	97	20.65
10	27	103	101	136	28.96	189¼	189	33¼	7.13	93	19.80
11	27	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
13	27	103	101	136	28.96	192¼	191	34¼	7.29	85	18.09
14	27	105	103	136	28.96	192¼	191	35¼	7.51	85	18.09
15	27 1/16	105¼	103	136	28.95	194¼	191	35	7.45	90	19.16

The above table gives the closing quotations on London Metal Exchange. All prices are in pounds sterling per ton of 2240 lb., except silver which is in pence per troy ounce of sterling silver, 0.925 fine. Copper quotations are for standard copper, spot and three months, and for electrolytic, price for the latter being subject to 3 per cent. discount. For convenience in comparison of London prices in pounds sterling per 2240 lb., with American prices in cents per pound the following approximate ratios are given, reckoning exchange at 4.80. £15 = 3.21c.; £20 = 4.29c.; £30 = 6.43c.; £40 = 8.57c.; £60 = 12.85c. Variations, £1 = 0.21½c.

Mar. 15 there was a sharp advance, a widespread demand, including galvanizers, having sprung up, not for any large tonnages, but rather for carload and two-carload lots from a good many quarters. May-June spelter had been sold during the morning at 14¼c., but in the afternoon 15⅞c. was bid for April-June.

The Kirk Smelting Co., a new concern, is building a smelting plant at Eufala, Oklahoma.

The American Zinc and Chemical Co. has just started the second block of its second unit, and will shortly complete and put into operation the third. The fourth, completing the unit, is not so far advanced.

Zinc Sheets are in good demand and sales have been large. The base price is unchanged at $25 per 100 lb., f.o.b. Peru, Ill., less 8% discount.

Other Metals

NEW YORK—Mar. 15

Aluminum—The market is less active and sales have been only moderate. Prices are a little easier, quotations being 58@60c. per lb. for No. 1 ingots, New York.

Antimony—The market continues strong, with business slightly less active. China and other ordinary brands are quoted at 44@45c. per lb., New York. Cookson's is scarce and is held at 57@60c. Futures are rather strong, March deliveries being offered at 43½c. and April at 42c. For shipments from China 34@35c. is quoted for March, and 33@34c. for April, both in bond.

Quicksilver—Some arrivals of supplies and slow buying have resulted in a sharp decline. This has not stirred up buyers, however, and the market is reported quiet. New York quotations are $225@230 per flask of 75 lb., according to size of order. Some outside sales are reported made at a discount, in one case as low as $190. San Francisco reports by telegraph $225@235 per flask, with small business. The London price is held unchanged, but no longer affects this market.

Nickel—Business is steady, with good domestic orders and a demand for export. Prices are unchanged at 45@50c. per lb. for ordinary forms, according to size and terms of order. Electrolytic metal is 5c. per lb. higher.

Gold, Silver and Platinum

NEW YORK—Mar. 15

Gold—The Netherlands Bank at Amsterdam on Jan. 31 held $187,668,534 gold, the largest amount ever reported by it. On June 30, 1914, the amount was $65,103,900, or not much more than one-third of its present reserve.

Platinum—There is nothing new in the market for this metal. Dealers are not willing to quote prices except to regular customers. Supplies are light and hardly up to the demand. Sales are reported made at $85@95 per oz. for refined platinum. Hard metal is quoted at $95@100 per oz. for 10% alloy.

Silver has been very steady at 27d. Today it is in demand at 27 1/16d. owing to the small arrivals in London during the past week, which is partly accounted for by the slow sailing of the boat last week from New York.—The home Mint and Continent are the chief buyers, India not much interested at present. London stock is estimated at £900,000 today.

Coined Silver in the United States Mar. 1 is estimated by the Treasury Department as follows: Standard dollars, $568,270,900; subsidiary coins, $187,514,641; total, $755,785,541. Of the standard dollars $482,021,751 are held in Treasury against silver certificates outstanding.

Zinc and Lead Ore Markets

JOPLIN, MO.—Mar. 11

Blende, high price $102.40; base per ton 60% zinc, premium ore, $100; medium grades, $95@85; lower grades down to $80; Calamine, per ton 40% zinc, $87.50@70; average selling price, all grades of zinc, $97.28 per ton. Lead, high price, $93; base per ton 80% metal contents $90@91; average selling price, all grades of lead, $87.30 per ton.

SHIPMENTS WEEK ENDED MAR. 11

	Blende	Calamine	Lead	Values
Totals this week..	14,356,640	250,950	2,830,560	$834,020
Totals this year...	134,319,510	11,106,000	21,461,130	$8,708,230

Blende value, the week, $701,310; 10 weeks, $7,420,790.

Calamine value, the week, $9,180; 10 weeks, $404,240.

Lead value, the week, $123,530; 10 weeks, $883,200.

For the hundredth time producers are talking of organizing a selling agency. A meeting, at which it is claimed 175 were in attendance, was held in Webb City, Wednesday night to talk on such an organization. They may do something this time, but it will take a long time to establish such an organization on a basis that will seem equitable to all. It is assumed it has none of the old-time element of attempting to bluff the smelters by a threatened organization. In the face of the talk prices were reduced $15 per ton on Friday. The production this week will be close to 9,000 tons.

PLATTEVILLE, WIS.—Mar. 11

The base price paid this week for 60% zinc ore was $95@98 per ton. The base price paid for 80% lead ore was $86 per ton.

SHIPMENTS WEEK ENDED MAR. 11, 1916

	Zinc ore, lb.	Lead ore, lb.	Sulphur ore, lb.
Week	4,308,000	.....	1,118,620
Year	41,834,000	699,700	9,746,240

Shipped during week to separating plants, 5,612,000 lb. zinc ore.

Iron Trade Review

NEW YORK—Mar. 15

There is no change to be reported in the condition of the iron market. Activity is undiminished and the question is whether producers will be able to keep up with the demand.

Freight conditions are not improved and delays in transportation are severely felt, especially in the East. Export trade is almost at a standstill.

It is announced that the Steel Corporation will spend about $25,000,000 in improvements and additions to the Gary plant. These will include a large tube mill and additional blast furnaces.

Pig iron from Florence and Sheffield furnaces of the Sloss-Sheffield Steel and Iron Co. is now being shipped to St. Louis and other Western markets by way of the Tennessee, Ohio and Mississippi rivers. Under recent decisions of the Interstate Commerce Commission the railroads north of the Ohio have to accept river business at proportional rates.

The United States Steel Corporation reports the total unfilled orders on its books Feb. 29 at 8,568,966 tons of material of all kinds. This is an increase of 646,199 tons during February, and exceeds by 179,248 tons the report for Dec. 31, 1906, which was, up to this time, the largest report ever made.

Pig Iron Production still increases. The reports of the furnaces, as collected and published by the "Iron Age," show that on Mar. 1 there were 312 coke and anthracite stacks in blast with a total daily production of 107,500 tons daily; an increase of 1,100 tons over Feb. 1. Making allowance for the charcoal furnaces, the production of pig iron in the United States in February was 3,122,200 gross tons; for the two months ended Feb. 29 the total was 6,343,100 tons.

Exports of Iron and Steel From the United States in January were as follows, tonnage of those exports which are reported by weight being given in gross tons:

	1915	1916	Changes
Tonnage exports	139,789	357,121	I. 217,332
Machinery, value	$7,676,078	$14,324,426	I. $6,648,348
Total value	18,053,421	51,643,807	I. 33,590,386

The heaviest items of tonnage reported this year were billets, ingots and blooms; wire; bars; sheets and plates; steel rails.

PITTSBURGH—Mar. 14

The advancing pace in steel prices has been well maintained during the past week. Yesterday morning the Carnegie Steel Co. announced an advance of $2 a ton in bars and shapes to 2.35c. and an advance in plates of $5 a ton to 2.60c., while today the National Tube Co. is mailing new discount cards effecting a general advance of one point, or about $2 a ton, in black steel pipe and two points in galvanized, with additional advances on a few sizes, and corresponding advances in oil country goods, while steel boiler tubes are advanced one point. Terne plate is up 15c. a box. Chain quotations at 4.50c. have disappeared, 5c. being the usual quotations, while the minimum on cold-rolled shafting has advanced from 30% to 35% off list, representing $5 a ton and it is difficult to buy except at 15% or 20% off list. The sheet market has stiffened noticeably, and galvanized sheets are definitely up $2 a ton, being squarely on a basis of 5c. for 28 gage. Unfinished steel is stronger all along the line.

While in some quarters there are predictions of an early break in some steel prices at least the steel producers evidently have no expectation of any break any time this year at the earliest. While it is difficult to conceive of steel prices continuing to advance as they have done in the past three months the scarcity of steel is evidently growing more pronounced, as shown both by the larger premiums paid for quick shipment, and the payment of premiums even for deliveries spread over the second half of the year. While the mill price on plates is 2.60c. the quotation seems to be more or less nominal, and ½-in. plates in carload lots for shipment in a fortnight have brought 3.50c. while deliveries over the second half have brought 3 cents.

The Steel Corporation's February increase of 646,199 tons in unfilled obligations indicates that its bookings exceeded its shipments by more than 50%, and necessarily the bookings

were chiefly for delivery far ahead. While the total obligations reported, 8,568,966 tons, now passes the old record made Dec. 31, 1906, the corporation is obligated a much smaller distance ahead, by reason of an increase of about 40% in capacity meanwhile, the obligations reported representing a tonnage equal to seven months of full production. Practically speaking the corporation doubtless has larger commitments as it will endeavor to take care of regular customers to the exclusion of business offered by prospective new customers.

Pig Iron—While there is still fairly active inquiry for pig iron the general observation made is that prices have not responded to the extent that would be expected, seeing that there is an acute scarcity of steel; while advances on this movement to date are about $25 a ton on finished and unfinished steel, more on specialties, and only $5 or $6 a ton on pig iron . The opinion is growing that something spectacular in the way of pig iron advances may occur very shortly, and the occasion may be buying by the Steel Corporation, at either Chicago or Pittsburgh. We quote: Bessemer, $20.50@21; basic, $18.50@19; foundry, $18.50@19; malleable, $19@19.50; forge, $18@18.50, f.o.b. Valley furnaces, 95c. higher delivered Pittsburgh.

Steel—The demand for unfinished steel has greatly increased, partly because demand has accumulated while steel mills were practically out of the market and partly because the larger premiums offered for certain finished steel products for early delivery justify finishing mills in bidding higher prices. Only an occasional seller appears, and of only a limited tonnage, but the market is certainly higher, and can be quoted nominally at about $40 for bessemer billets and sheet bars and $44@45 for openhearth. It is probable that tens of thousands of tons of specific orders could be booked by mills in a few days if they offered steel at these figures. Special steels command still fancier prices than formerly, forging billets being $60@85, depending on analysis and delivery. While ordinary rods are quotable strong at $55, high carbon rods are bringing $75@85 per ton.

FERROALLOYS

Spiegeleisen has advanced sharply. A Pittsburgh report is that $100 per ton has been paid for spot delivery, but this cannot be confirmed. It is known, however, that premiums have been paid on the quoted price of $50 for 20% metal.

Ferrosilicon is quoted at $85, Pittsburgh, for 50%. For bessemer ferrosilicon prices range from $31 for 10% up to $41 for 16%, at furnace.

Imports at Baltimore for the week included 785 tons ferromanganese from Liverpool.

Ferromanganese—The situation in ferromanganese is an utterly wild one. The $250 price reported a week ago as obtainable on prompt lots has entirely disappeared and there are reports of transactions at as high as $400. Some English producers still quote $175 on contract, but shipment would hardly be expected before the last quarter of the year at the earliest.

FOREIGN IRON

British Exports and Imports of Iron and Steel and manufactures thereof in the month of January, as valued by the Board of Trade returns:

	Exports	Imports	Excess
Iron and steel	£4,021,819	£795,787 Exp.	£3,226,032
Hardware, machinery, etc.	2,316,819	1,246 368 Exp.	1,070,451
Totals	£6,338,638	£2,042,155 Exp.	£4,296,483
Total, 1915	5,133,050	1,511,824 Exp.	3,621,226
Total, 1914	9,169,101	2,500,402 Exp.	6,668,699

Actual tonnage of iron and steel exported in 1916 was 287,350 gross tons, an increase of 62,722 tons over 1915; imported, 68,139 tons, a decrease of 741 tons.

IRON ORE

Shipments from Lake Erie docks continue heavy, and stocks are being drawn down so that it is apparent they will be pretty light before the season shipments begin.

NEW CALEDONIA ORES

Shipments of ores from New Caledonia for the year ended Dec. 31 are reported by the "Bulletin du Commerce" of Noumea at 48,476 metric tons nickel ore and 57,474 tons of chrome ore.

OTHER ORES

Antimony Ore is in some demand and sales have been made of good lots at $2.70 per unit.—**Tungsten Ore** continues strong and up to $85 per unit is reported paid.

Manganese Ore has been sold at 70@75c. per unit at tidewater. There is much inquiry for Brazilian ore.

Imports at Baltimore for the week included 6,000 tons manganese ore from Rio Janeiro.

COKE

Coke production for the week in the Connellsville region is reported by the "Courier" at 444,342 net tons; shipments, 438,038 tons. Shipments of Greensburg and Upper Connellsville districts, 44,636 tons.

Anthracite Shipments in February were 5,696,506 gross tons, an increase of 1,346,391 tons over February, 1915. For the two months ended Feb. 29 the total shipments were 9,183,514 tons in 1915, and 11,580,656 tons in 1916; increase, 2,397,142 tons.

The Coal Production of Belgium in 1915 as reported from German sources was: Coal, 14,238,172 metric tons; coke, 484,481 tons; briquettes, 1,202,635 tons. The coal mined was about two-thirds of the normal output; the coke less than one-fourth.

Coal Production in Germany for three years past is officially reported as follows, in metric tons:

	1913	1914	1915
Coal	191,511,154	161,535,224	148,712,350
Brown coal	87,116,343	83,946,906	88,369,554
Coke made	32,167,710	27,324,712	26,359,430
Briquettes made	27,241,755	27,397,529	29,742,948

Of the briquettes made in 1915 a total of 23,350,464 tons was made from brown coal, or lignite.

Exports of Fuel From Great Britain in the month of January were as follows, in gross tons:

	1915	1916	Changes
Coal	3,612,963	3,171,200	D. 441,763
Coke	92,597	112,809	I. 20,212
Briquettes	64,038	99,090	I. 35,052
Bunker coal	1,377,081	1,069,244	D. 307,837
Total	5,146,679	4,452,343	D. 694,336

The bunker coal is coal furnished to steamships in foreign trade. There were no imports of coal in January of this year.

Coal Production in European Russia in 1915 is reported at 27,820,632 long tons, against 32,513,656 tons in 1914 and 33,204,752 tons in 1913. Coal production in Siberia was 2,798,528 tons, against 2,442,944 tons in 1914 and 2,153,648 tons in 1913. The coke made in Russia in 1915 was 4,001,000 tons, a decrease of 466,000 tons from the previous year.

Chemicals

NEW YORK—Mar. 15

The chemical markets generally show some activity, and the undertone is strong, with advances expected in some lines.

Arsenic—There is some scarcity of supplies, and the market has been firm. Business has been done at $5.75@6 per 100 lb. for spot, but holders are asking 50c. more for futures.

Copper Sulphate—Demand for export is good, but domestic orders have been rather scarce and prices are a little easier. For carload lots 21c. per 100 lb. is quoted; for smaller orders 21.25@21.50c. Some cutting in prices is talked of.

Nitrate of Soda—Sales have been good and prices hold at $3.60 per 100 lb. for spot material. Stocks in Chile on Feb. 1 are reported at 772,000 tons, an increase of 282,000 tons over Feb. 1, 1914. This shows a production in excess of shipments, but the price here is kept up by high freight rates.

Pyrites—Imports at Baltimore for the work included 10,732 tons iron pyrites from Huelva, Spain.

Sulphur—Demand is active and the market very strong. The advance due to high freight rates has been held and sales are made at $28.50@29 per long ton.

Sulphuric Acid—Spot supplies are rather scarce, but futures are offered more freely. Quotations for 60-deg. acid are $25 per ton, on cars at works, buyer to furnish tank cars. For 66-deg. acid $50 per ton is asked on contracts.

Imports and Exports of Fertilizing Chemicals in the United States year ended Dec. 31, as reported by the Department of Commerce, in gross tons:

	Imports		Exports	
	1914	1915	1914	1915
Kainit	329,611	6,674	300	.....
Manure salts	168,426	12,947	.....	.....
Other potash salts	204,773	69,088	3,911	565
Nitrate of soda	541,715	772,190	9,220	22,943
Sulphate of ammonia	74,121	32,477	263	1,204
Phosphates	.....	.....	964,114	253,549

Exports include reëxports of foreign material. Some phosphates are imported, but are not given separately in the returns.

Assessments

Company	Delinq.	Sale	Amt.
Adventure, Mich.	Mar. 20		$0.50
Adventure, Mich.	July 20		0.50
Basalt, Nev.	Mar. 8	Apr. 6	0.003
Beaver, Utah.	Mar. 18	Apr. 8	0.01
Cash Boy, Nev.	Feb. 16	Mar. 20	0.01
Con. Virginia, Nev.	Mar. 14	Apr. 4	0.05
East Caledonia, Ida.	Mar. 21	Apr. 10	0.01
Emerald, Utah.	Mar. 15	Apr. 11	0.00½
Enterprise, Ida.	Feb. 4	Mar. 20	0.002
Federal Ely, Nev.	Mar. 1	Apr. 3	0.005
Federal Ely, Nev.	Apr. 1	May 1	0.005
Federal Ely, Nev.	May 1	June 4	0.005
Flagstaff, Ida.	Mar. 20	Apr. 15	0.002
Four Timbers, Ida.	Feb. 24	Mar. 24	0.002
Imperial, Ida.	Feb. 19	Mar. 20	0.003
International, Ida.	Mar. 16	Apr. 1	0.002
Mayflower, Ida.	Mar. 15	Apr. 15	0.005
Monarch Pitts, Nev.	Feb. 18	Mar. 20	0.01
Mountain Rose, Ida.	Mar. 8	Apr. 8	0.001
Native Silver, Mont.	Feb. 21	Apr. 4	0.0025
New Bonanza, Utah.	Feb. 28	Mar. 18	0.00125
New Quincy, Utah.	Mar. 11	Mar. 30	0.01
Old Veteran, Ida.	Mar. 9	Apr. 1	0.002
Ophir, Nev.	Mar. 22	Apr. 12	0.05
Paloma, Utah.	Mar. 18	Apr. 8	0.01
Park Gold, Utah.	Apr. 1	Apr. 20	0.001
Queen Bess, Utah.	Feb. 20	Mar. 20	0.005
Rio Grand Grubstake, Nev.	Mar. 27	Apr. 22	0.006
Rockford, Ida.	Mar. 15	Apr. 15	0.001
Sandstorm Kendall, Nev.	Feb. 21	Mar. 27	0.01
Silver Moon, Ida.	Feb. 26	Mar. 22	0.005
Silver Pick Con., Nev.	Feb. 28	Apr. 3	0.01
Sixes Min., Nev.	Mar. 17	Apr. 1	0.10
Summit Ex., Utah.	Mar. 15	May 1	0.01
Sunset, Nev.	Mar. 27	Apr. 29	0.01
Tintic Milling, Utah.	Mar. 14	Apr. 3	0.03
Tintic Standard, Utah.	Mar. 15	Apr. 10	0.005
Tono, Gypsy Qn., Nev.	Mar. 20	Apr. 24	0.01
Utah Metals, Utah.	Mar. 11	Apr. 15	0.001
Utah-United, Utah.	Mar. 10	Mar. 30	0.01
Uvada, Nev.	Feb. 21	Mar. 30	0.02
West Toledo, Utah.	Mar. 6	Mar. 22	0.01

Stock Quotations

Sales at auction: North Butte Extension, 1,100 shares at 16c. per share; in Philadelphia, Victoria Gold Mining Co. of Ariz., $1 lot; in Boston, 1,000 Porcupine Premier, $1 par, 40c. each.

COLO. SPRINGS Mar. 14		SALT LAKE Mar. 14	
Name of Comp.	Bid.	Name of Comp.	Bid.
Acacia	‡.04½	Beck Tunnel	.20
Cripple Cr'k Con.	‡.007	Black Jack	‡.13
Dante	‡.02	Colorado Mining	.20½
Doctor Jack Pot	.10½	Crown Point	.05
Elkton Con.	.32	Daly-Judge	8.00
El Paso	.80	Emma Cop.	.48
Findlay	.05½	Gold Chain	.26
Gold Dollar	.02	Grand Central	.79
Gold Sovereign	.04½	Iron Blossom	1.77½
Golden Cycle	2.08	Lower Mammoth	.06½
Isabella	.22½	May Day	.15
Jack Pot	.06½	Opohongo	‡.03
Jerry Johnson	‡.05	Prince Con	1.17½
Lexington	‡.005	Seven Troughs	‡.01½
Mary McKinney	.45	Silver King Coal'n	3.27½
Pharmacist	‡.009	Silver King Con.	1.82½
Portland	1.78	Sioux Con.	.11
Raven B. H.	‡.01	Uncle Sam	.09½
Vindicator	2.37	Yankee	.28

SAN FRANCISCO Mar. 14			
Alta	.05	Belmont	4.10
Andes	.06	Jim Butler	.85
Best & Belcher	.03	Lone Star	.02
Bullion	.01	MacNamara	.07
Caledonia	.30	Midway	.17
Challenge Con.	.05	Mont.-Tonopah	.21
Confidence	‡.15	North Star	.14
Con. Virginia	.11	Rescue Eula	.25
Gould & Curry	.02	West End Con.	.69
Hale & Norcross	.04	Atlanta	.16
Jacket-Cr. Pt.	.10	Blue Bell	.02
Julia	‡.01	Booth	.66
Mexican	.16	C.O.D. Con.	.03
Occidental	.75	Comb. Frac.	.07
Ophir	.16	D'field Daisy	.03
Overman	.04	Jumbo Extension	.85
Savage	.14	Pitts.-Silver Peak	.07
Seg Belcher	.02	Round Mountain	.57
Sierra Nevada	.32	Sandstorm Kendall	.05
Union Con.	.42	Silver Pick	.07
Utah Con.	.02	Central Eureka	.14

TORONTO Mar. 14			
Bailey	.05½	Dome Exten.	.38½
Chambers Ferland	.20	Dome Lake	.26½
Coniagas	3.87½	Foley O'Brien	.50
La Rose	.61	Hollinger	26.75
Peterson Lake	.26	Imperial	‡.03½
Right of Way	.04	Jupiter	.21
Seneca Superior	.55	McIntyre	.91
T. & Hudson Bay	26.00	Porcu. Crown	.73
Temiskaming	.52½	Preston E. D.	‡.04½
Trethewey	.12	Vipond	.61
Wettlaufer-Lor.	.07	West Dome	‡.14½

LONDON Mar. 1			
Alaska Tr'dwell	£6 10s 0d	Mexico Mines	£3 13s 9d
Burma Corp.	1 16 6	Nechi, pfd.	0 13 6
Cam & Motor	0 11 6	Oroville	0 13 6
Camp Bird	0 7 0	Santa Gert'dis	0 10 6
El Oro	0 8 3	Tomboy	1 1 6
Esperanza	0 10 6	Tough Oakes	0 12 6

N. Y. EXCH. Mar. 14		BOSTON EXCH Mar. 14	
Name of Comp.	Clg.	Name of Comp.	Bid
Alaska Gold M.	20½	Adventure	2¾
Alaska Juneau	9½	Ahmeek	404
Am.Sm.&Ref.,com	101½	Algomah	1¾
Am. Sm. & Ref., pf.	112¾	Allouez	72½
Am. Sm. Sec., pf. A	93½	Ariz. Com., ctfs.	8½
Am. Sm. Sec., pf. B.	87	Bonanza	.35
Am. Zinc	85½	Butte Alex. Scott	‡10½
Anaconda	88	Butte-Ballaklava	4½
Batopilas Min.	2¾	Calumet & Ariz.	72½
Bethlehem Steel	549	Calumet & Hecla	560
Bethlehem Steel, pf.	135	Centennial	16½
Butte & Superior	94	Copper Range	65½
Chile Cop.	22½	Daly West	3½
Chino	55½	East Butte	12½
Colo. Fuel & Iron	46¾	Franklin	9¾
Crucible Steel	93½	Granby	91
Dome Mines	25¾	Hancock	16
Federal M. & S.	29	Hedley	22
Federal M. & S., pf.	53¾	Helvetia	.40
Great Nor., ore., ctf.	45¾	Indiana	4
Greene Cananea	49¼	Island Cr'k, com.	46
Guggen. Exp.	21	Island Cr'k, pfd.	90
Homestake	127¾	Isle Royale	29
Inspiration Con.	47	Keweenaw	3¾
International Nickel	48¾	Lake	17½
Kennecott	56¼	La Salle	4¾
Lackawanna Steel	79¾	Mason Valley	3
Miami Copper	36½	Mass	13¾
Nat'l Lead, com.	67½	Mayflower	4
National Lead, pf.	113	Michigan	2¾
Nev. Consol.	16	Mohawk	102
Ontario Min.	7	New Arcadian	8½
Quicksilver	4¾	New Idria	17½
Quicksilver, pf.	6½	North Butte	30
Ray Con.	24½	North Lake	1½
Republic I&S, com.	54	Ojibway	1¾
Republic I&S, pf.	111¾	Old Colony	3½
Sloss-Sheffield	58½	Old Dominion	72½
Sloss-Sheffield, pf.	97½	Osceola	100½
Tennessee Copper	58	Quincy	94½
Utah Copper	82¾	St. Mary's M. L.	71
U. S. Steel, com.	86½	Santa Fe	3
U. S. Steel, pf.	116¾	Shannon	10
Va. Iron C. & C.	54	Shattuck-Ariz.	37¾
		So. Lake	7
		So. Utah	.30
		Superior	17
		Superior & Bost.	3½
		Tamarack	51½
		Trinity	9¾
		Tuolumne	.17
		U. S. Smelting	67¾
		U. S. Smelt'g, pf.	50¾
		Utah Apex	4½
		Utah Con.	14½
		Utah Metal	11
		Victoria	3¾
		Winona	4
		Wolverine	60½
		Wyandot	2

N. Y. CURB Mar. 14	
Alta Con.	‡.24
Beaver Con.	.36½
Big Four	‡.04
Buffalo Mines	1 1/16
Butte & N. Y.	3/16
Butte C. & Z.	9¾
Can. Cop. Corpn.	1½
Cashboy	.05
Cerro de Pasco	38½
Con. Ariz. Sm.	1 5/16
Con. Coppermines	1¼
Con. Nev.-Utah	⅛
Dia. Black B.	.02
First Nat. Cop.	6
Florence	.43
Goldfield Con.	.91
Goldfield Merger	.12½
Hecla Min.	4½
Howe Sound	5¼
Kerr Lake	3¼
Magma	17½
Majestic	1/16
McKinley-Dar-Sa.	.42
Mines of Am.	3
Mother Lode	.30
Nevada Hills	.19
New Utah Bingham	4
Nipissing Mines	6¼
Oro	.04
Ray Hercules	3
Rochester Mines	.63
St. Joseph Lead	16½
Stand'd Oil of N.J.	523
Standard S. L.	1½
Stewart	1/16
Success	.84
Tonopah	6½
Tonopah Ex.	4½
Tonopah Merger	.55
Tribullion	.50
White Knob, pf.	1¾
Yukon Gold	2½

BOSTON CURB Mar. 14	
Bingham Mines	12½
Boston Ely	.40
Butte & Lon'n Dev.	.73
Calaveras	3
Calumet-Corbin	.05
Chief Con.	1 1/16
Cortez	.85
Crown Reserve	.38
Davis-Daly	1¼
Eagle & Blue Bell	1 1/16
Houghton Copper	2½
Iron Cap Cop., pf.	6
Mexican Metals	.53
Mojave Tungsten	5
Nat. Zinc & Lead	3½
Nevada-Douglas	.90
New Baltic	3
New Cornelia	13
Ohio Copper	.18
Oneco	1
Raven Copper	.18
Rex Cons.	.17
Rilla	1½
United Verde Ext.	17½

‡Last Quotations.

Monthly Average Prices of Metals

SILVER

Month	New York			London		
	1914	1915	1916	1914	1915	1916
January	56.572	48.855	56.775	26.553	22.731	26.953
February	57.506	48.477	56.755	26.573	22.753	26.975
March	58.067	50.241	.....	26.788	23.708	.....
April	58.519	50.250	.....	26.958	23.709	.....
May	58.175	49.915	.....	26.704	23.570	.....
June	56.471	49.034	.....	25.948	23.267	.....
July	54.678	47.519	.....	25.219	22.597	.....
August	54.344	47.163	.....	25.979	22.780	.....
September	53.290	48.680	.....	24.260	23.591	.....
October	50.654	49.385	.....	23.199	23.925	.....
November	49.082	51.714	.....	22.703	25.094	.....
December	49.375	54.971	.....	22.900	26.373	.....
Year	54.811	49.604	.....	27.314	23.675	.....

New York quotations cents per ounce troy, fine silver; London, pence per ounce, sterling silver, 0.925 fine.

COPPER

Month	New York Electrolytic		London Standard		London Electrolytic	
	1915	1916	1915	1916	1915	1916
Jan.	13.641	24.008	60.756	88.083	65.719	116.17
Feb.	14.394	26.440	63.494	102.667	*	133.167
Mar.	14.787	.....	66.152	.....	*	.....
April	16.811	.....	75.096	.....	*	.....
May	18.506	.....	77.600	.....	*	.....
June	19.477	.....	82.574	.....	95.333	.....
July	18.796	.....	76.011	.....	91.409	.....
Aug.	16.941	.....	68.673	.....	82.333	.....
Sept.	17.502	.....	68.915	.....	85.250	.....
Oct.	17.686	.....	72.601	.....	88.000	.....
Nov.	18.627	.....	77.744	.....	93.273	.....
Dec.	20.133	.....	80.773	.....	100.43	.....
Year	17.275	.....	72.532	.....	.....	.....

TIN

Month	New York		London	
	1915	1916	1915	1916
January	34.260	41.825	156.550	175.548
February	37.415	42.717	176.925	181.107
March	48.426	.....	180.141	.....
April	47.884	.....	166.225	.....
May	38.790	.....	162.675	.....
June	40.288	.....	167.636	.....
July	37.423	.....	167.080	.....
August	34.389	.....	151.440	.....
September	33.125	.....	152.625	.....
October	33.080	.....	151.554	.....
November	39.224	.....	167.670	.....
December	38.779	.....	167.000	.....
Av. year	38.500	.....	163.960	.....

LEAD

Month	New York		St. Louis		London	
	1915	1916	1915	1916	1915	1916
January	3.729	5.921	3.548	5.826	18.606	31.167
February	3.827	6.246	3.718	6.164	19.122	31.988
March	4.053	.....	3.997	.....	21.883	.....
April	4.221	.....	4.142	.....	21.094	.....
May	4.274	.....	4.182	.....	20.347	.....
June	5.932	.....	5.836	.....	25.170	.....
July	5.659	.....	5.531	.....	24.611	.....
August	4.656	.....	4.520	.....	21.946	.....
September	4.610	.....	4.490	.....	23.151	.....
October	4.600	.....	4.499	.....	23.994	.....
November	5.155	.....	5.078	.....	26.278	.....
December	5.355	.....	5.266	.....	28.807	.....
Year	4.628	.....	4.587	.....	22.917	.....

SPELTER

Month	New York		St. Louis		London	
	1915	1916	1915	1916	1915	1916
Jan.	6.386	16.915	6.211	16.745	30.844	89.810
Feb.	8.436	18.420	8.255	18.260	39.819	97.762
Mar.	8.541	.....	8.360	.....	44.141	.....
April	10.012	.....	9.837	.....	49.888	.....
May	14.781	.....	14.610	.....	68.100	.....
June	21.208	.....	21.038	.....	100.614	.....
July	19.026	.....	18.856	.....	97.250	.....
Aug.	12.781	.....	12.611	.....	67.786	.....
Sept.	13.440	.....	13.270	.....	67.841	.....
Oct.	12.800	.....	12.596	.....	66.536	.....
Nov.	15.962	.....	15.792	.....	88.409	.....
Dec.	15.391	.....	15.221	.....	89.400	.....
Year	13.230	.....	13.054	.....	67.553	.....

New York and St. Louis quotations, cents per pound, London, pounds sterling per long ton. * Not reported.

PIG IRON IN PITTSBURGH

Month	Bessemer		Basic		No. 2 Foundry	
	1915	1916	1915	1916	1915	1916
January	$14.59	$21.60	$13.45	$18.78	$13.90	$19.70
February	14.55	21.16	13.45	18.93	13.90	19.51
March	14.55	.....	13.45	.....	13.95	.....
April	14.55	.....	13.45	.....	13.95	.....
May	14.64	.....	13.60	.....	13.83	.....
June	14.70	.....	13.67	.....	13.77	.....
July	14.94	.....	13.91	.....	13.68	.....
August	16.01	.....	15.31	.....	14.75	.....
September	16.86	.....	15.95	.....	15.70	.....
October	16.95	.....	15.96	.....	15.80	.....
November	18.26	.....	17.30	.....	17.20	.....
December	19.95	.....	18.95	.....	18.95	.....
Year	$14.89	.....	$13.76	.....	$13.89	.....